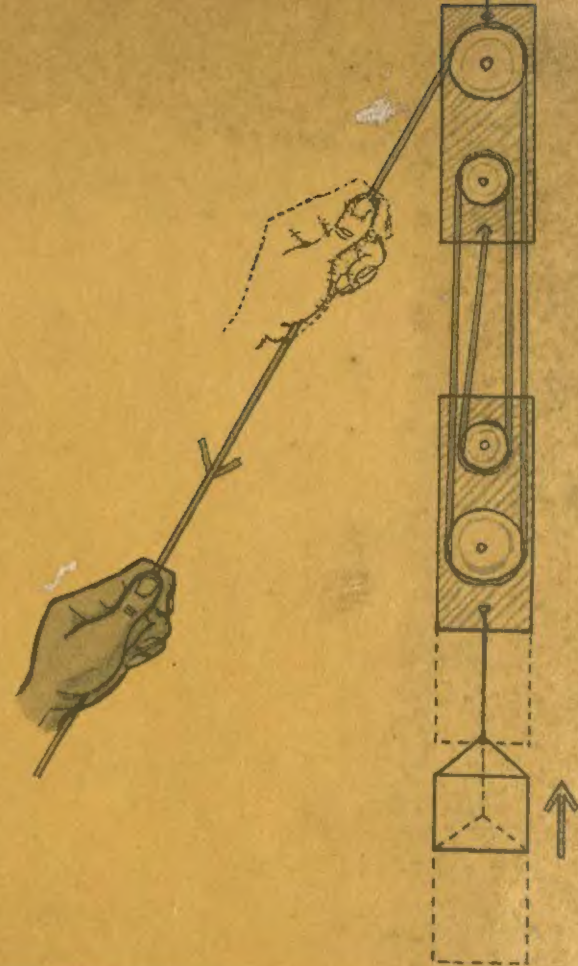
Life and Living 4

Young Life, the Earth and Machines



B. H. G. CHAPLIN

A Contemporary Science Course for Tropical Schools

Notes to Pupils

We hope you will find this book something new, different and exciting. It is full of things for you to do. In doing them you will begin to understand the way in which some of the world around you works. Also you will learn to begin real scientific thinking for yourself—the sort of thinking that helped men to make the aeroplane and discover atomic energy, and may one day lead you to discover who knows what?

You are to find out with your hands and eyes how things work, and this will help you to understand the small amount of important information which is found in this book. If you do it this way, then you will understand and never forget.

There are two things you must do:

1. Bring early the things needed to do the experiments.
2. Take great care to perform the experiments exactly, and to be honest about them.

None of the pictures here are to be copied, they are only to help you to know what to do and how to find out.

If you find it hard to write down what you have found out, always ask for help from your teacher.

Illustrations by Valerie Herbst

Life and Living 4

CONTENTS

LONGMANS

These are two ways of keeping water-plants and animals in the classroom.

They should be placed where they can be in sunshine for part of the day only.

You will not always be able to get them all, and you may get other things that are not shown. Try to collect enough plants to fill the jars well, and also have extra specimens that you can press and keep. (See Book I, p. 23.) One or two groups could press and mount specimens.

The Experiment: Put a small jar with some algae in it mouth downwards in each of two big jars. Make sure there is no air in them at all. Put one in the shade and leave the other in a sunny place.

At the end of a week look at them. What do you think is in the little jars? Where did it come from? Write your answers. (Book 3, p. 23 will help you.) Draw any water-animals that are large enough to be seen. One or two groups could kill and mount some of them.

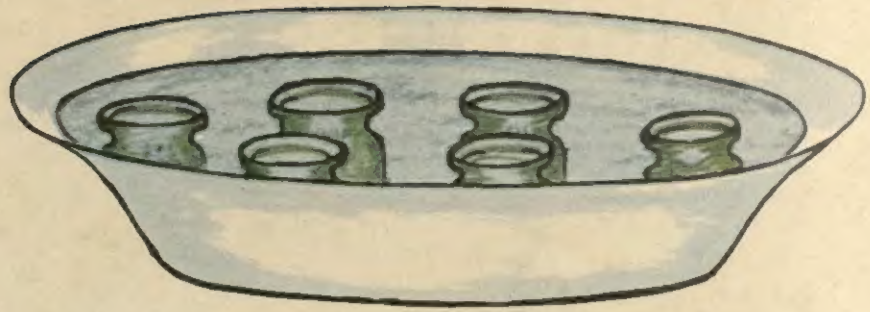
Plants breathe out small amounts of the 'burning part' of air, which chemists call OXYGEN, and during the day they breathe in small amounts of the 'used up part' of the air, which chemists call CARBON DIOXIDE. On the other hand, animals breathe in large quantities of Oxygen, and breathe out large quantities of Carbon Dioxide. Therefore will your jars have to contain a big majority of plants? Or a big majority of animals? Or equal amounts of each?

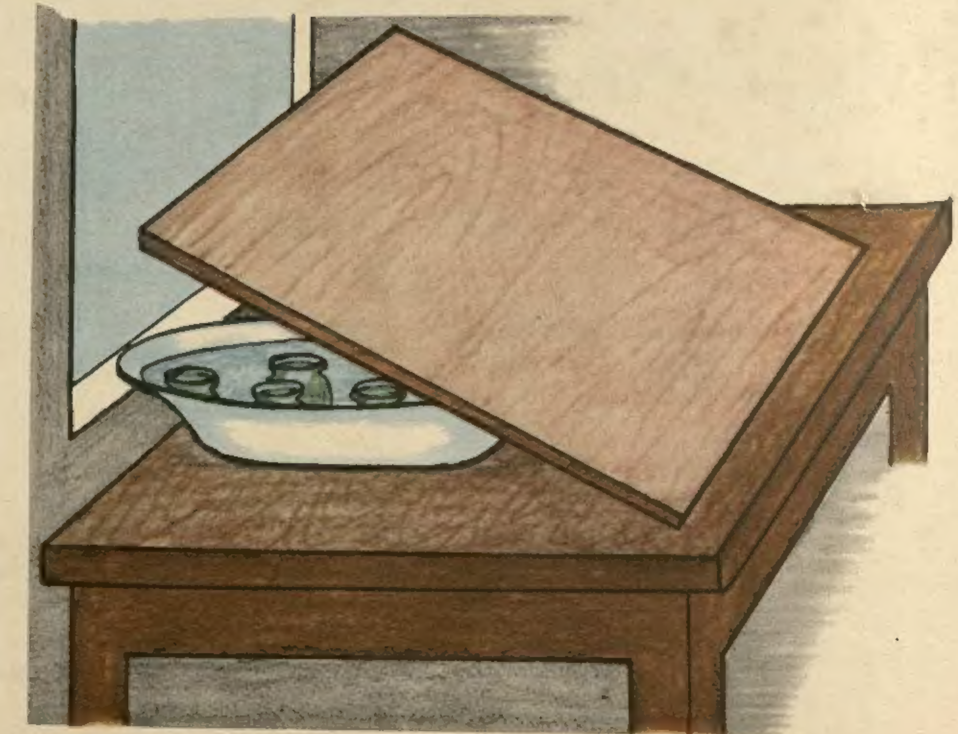
The whole success of the little living world you have set up in the jar depends on your answer. If there is a correct balance then life will go on there permanently, and you will only have to fill up with clean water from time to time to make up for evaporation.

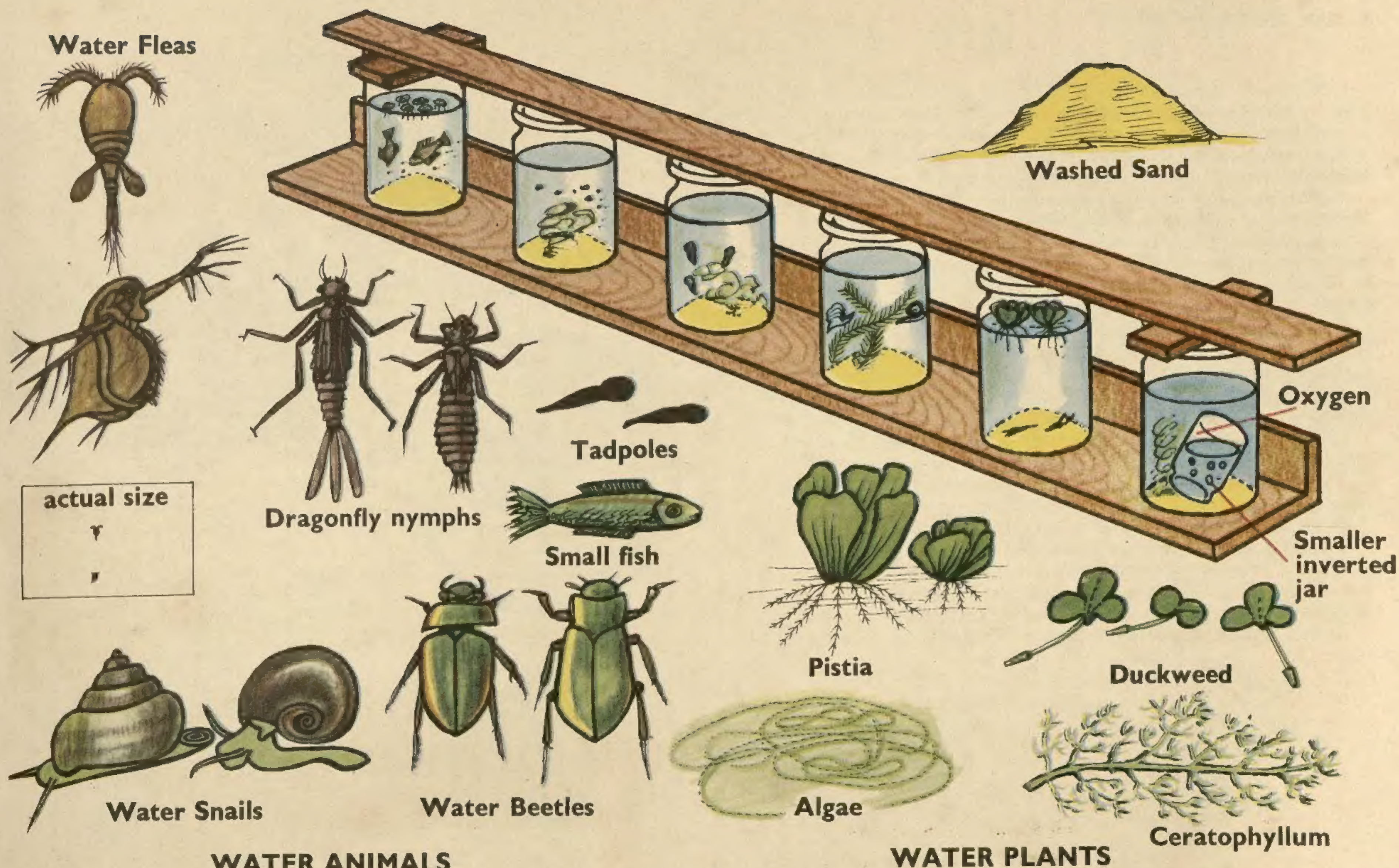
There are also likely to be many things in the jar that are too small to draw, and many more that are even too small for your eyes to see, though they are there. Later you will find out how to see them.

Watch the jars carefully. In your Nature Book draw and make notes of everything you see happening.

Jars 1" below surface






Water Fleas
actual size
Dragonfly nymphs
Tadpoles
Small fish
Washed Sand
Oxygen
Smaller inverted jar
Pistia
Duckweed
Water Snails
Water Beetles
Algae
Ceratophyllum
WATER ANIMALS
WATER PLANTS

Many animals come from eggs laid by the female. An animal, however, does not grow in an egg unless a very small SPERM from the male joins with the live part of the egg. Males send out thousands of sperms to every egg the female makes, but only one sperm ever joins with the live part of the egg so that it grows into a new animal.

Remember that this is true of flowering plants too. The yellow dust called pollen comes from the male part of the flower, and one tiny grain joins with each 'possible seed' in the female part of the flower. In plants you can see pollen grains, but in animals the sperms are far too small to be seen with your eyes alone. Those shown with the egg in 2 have been magnified over a thousand times.

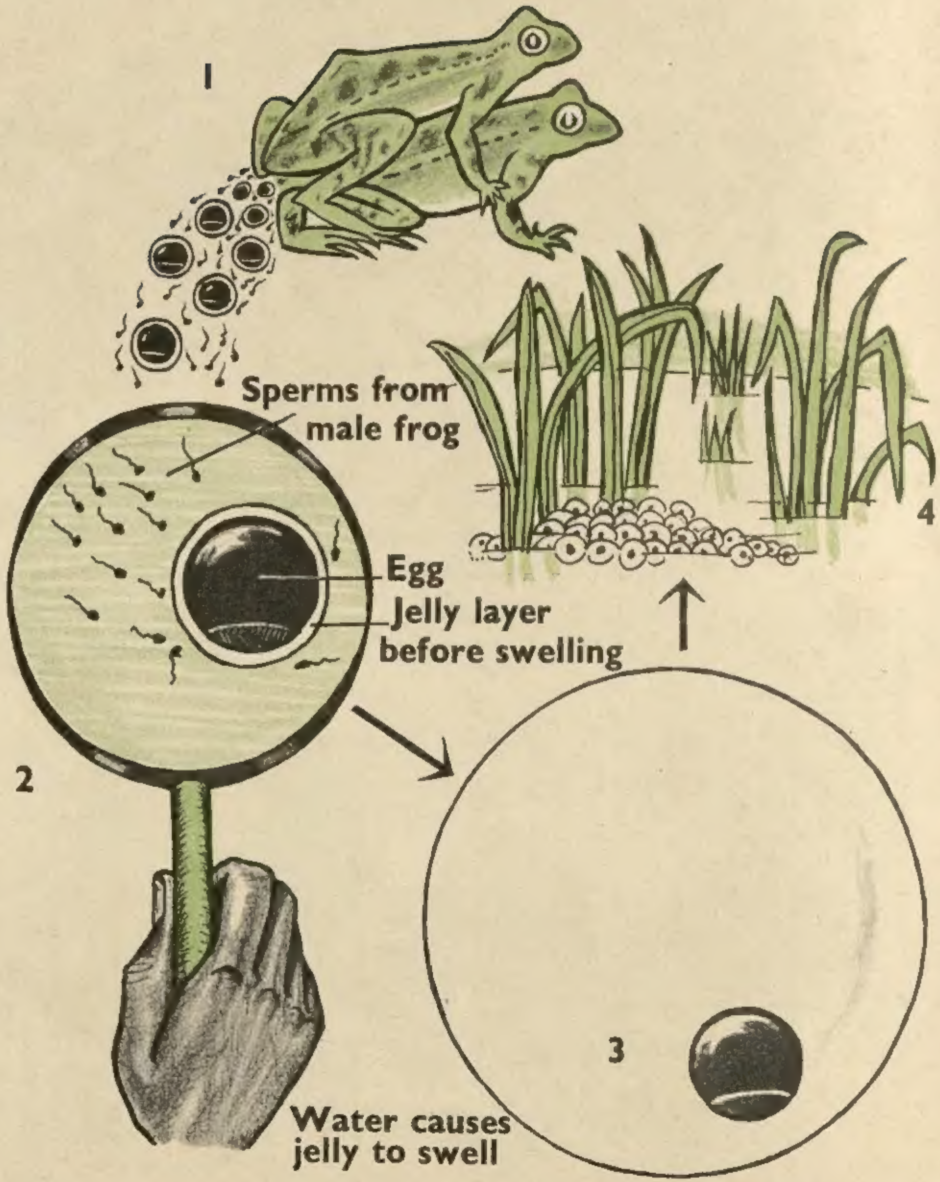
Set up a Nature Table collection of the eggs of animals. Where possible include part of the place where they were found: e.g. moth eggs on a leaf, ant eggs in part of an anthill, and so on. Write down where and when you found them. Draw them, and if they change at all, make new drawings to show the change.

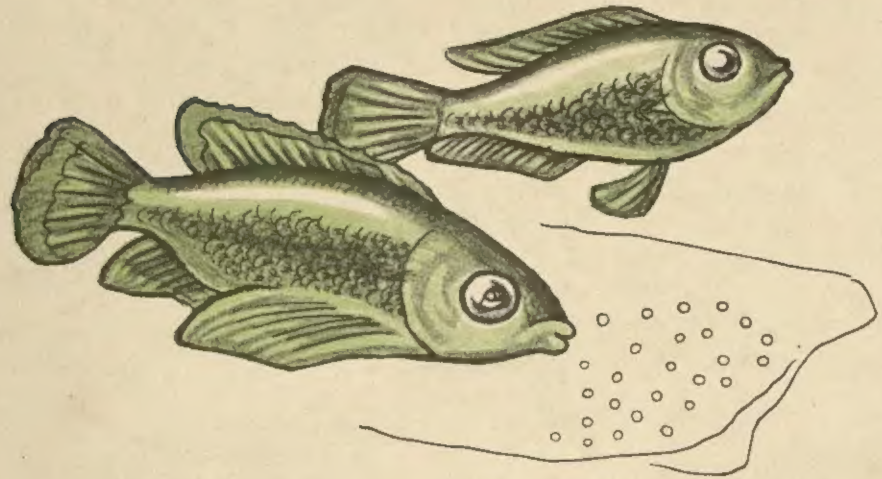
When it is the right season, collect frog spawn and watch it develop in jars. Draw the changes you see. Frogs' eggs are really very small, but they have a special jelly round them, which swells up as soon as it is in the water and protects the real egg, a black dot, inside.

Write down any other ways in which eggs are protected.

List all the animals you know that come from eggs.

Write all you know about the ways in which some of these animals look after their eggs. As far as possible groups or individuals should write about different animals. They can then read their notes to the class. At a minimum six different animals should be written about.





Gecko newly hatched

HOW AN EMBRYO DEVELOPS INSIDE AN EGG

These pictures are only diagrams to show you what happens. Until the egg grows, everything is too small to be seen.

Hens can lay eggs without the cock supplying sperms, but unless a sperm is joined to the egg inside the hen BEFORE the white and yellow part of the egg starts to form, it will never become a chicken.

Help your teacher to get six or more 'fertilised' eggs, and keep them with the hens to hatch them.

Those of you in the class who keep chickens at home must arrange to mark (with pencil) at least six 'fertilised' eggs as soon as they have been laid, and then they must be placed back under the hens again for hatching. Then one egg should be brought to school after one day and carefully broken open. Look for the little place where the chick is beginning to grow.

Inside the mother hen the real 'seed' part does not grow much, but the 'yolk' (yellow part) and the 'white' part are added before the egg comes out of her. Do you remember that the seed of a plant had one or two food storage leaves that supplied the tiny plant with food until it could make its own? Your teacher will help you to revise this. The yolk is the food-store in the egg. Then when the egg is out of the hen, the little spot you saw after one day grows bigger. It has to feed on something and starts to use up the yolk.

Your teacher will open another fertilised egg after four days. Notice the blood vessels running from the 'embryo' into the yolk.

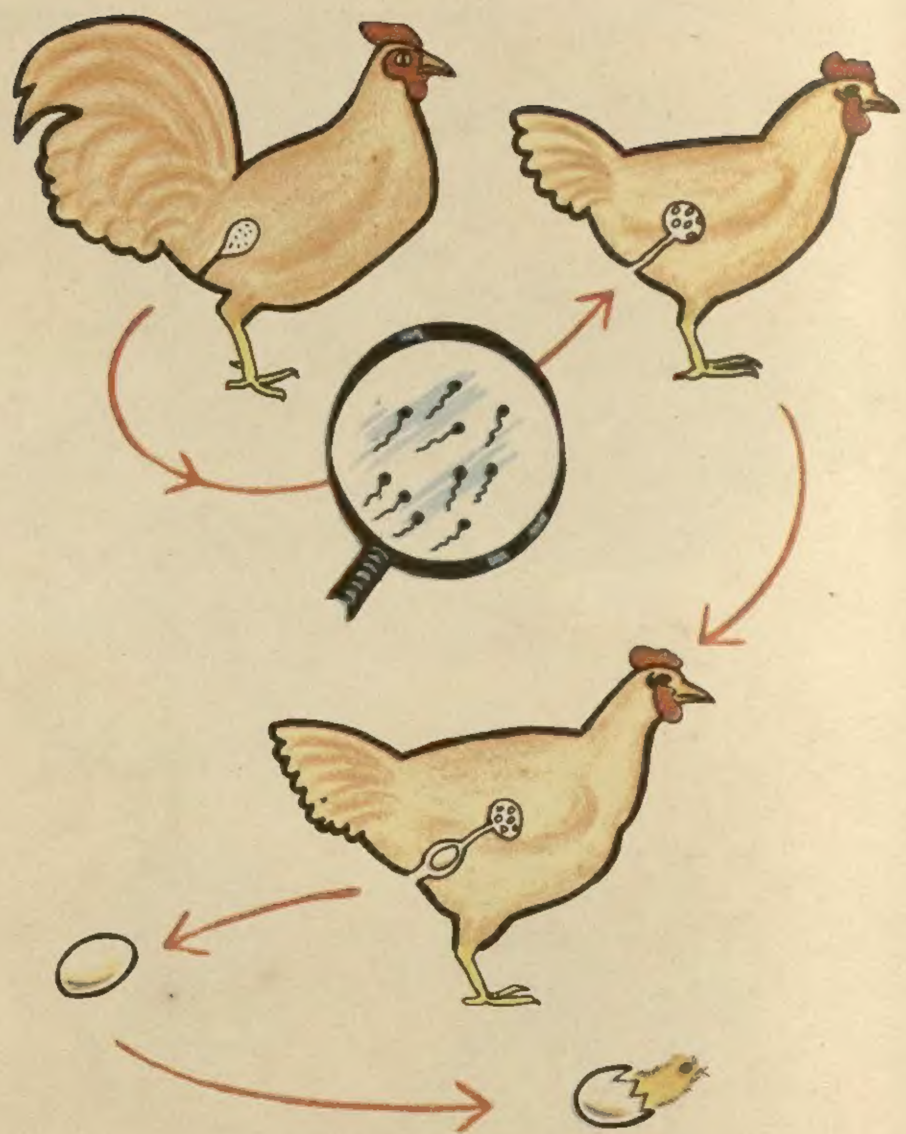
When your teacher opens an egg after nine days, you will also see that some blood vessels are going to the outer part of the egg under the shell. Write about what you have seen happening, and say what you think both sets of blood vessels are for. (Referring to Book 3 will help.)

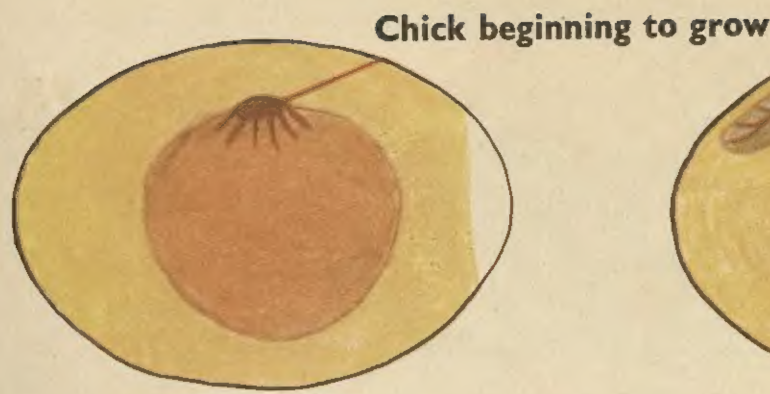
Is there any way the growing chick can get air as well as food?

Your teacher will open eggs at 16 and 21 days. Describe each time what you see, in your Nature Diary. Leave the sixth egg to hatch out. Other animals and birds take different lengths of time to hatch out.

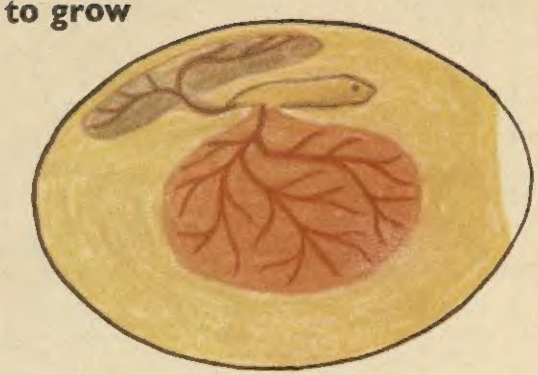
The real seed part, that grows before it starts to breathe and live for itself as a new animal or plant, is called by the scientific name EMBRYO. You have been examining the growth of a chick embryo.

Look for a plant embryo inside a bean seed.





One day

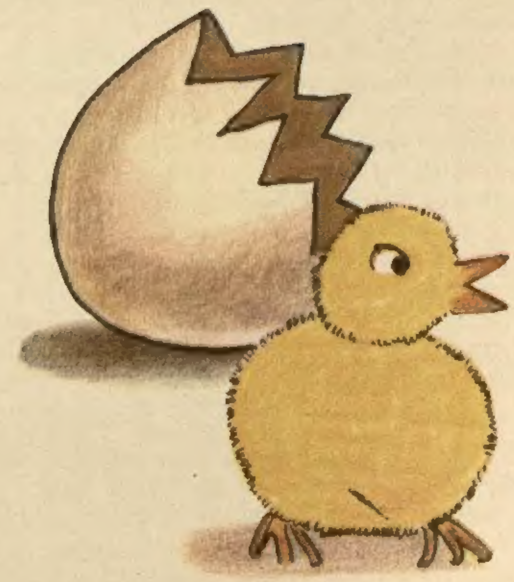


Four days

Nine days

Sixteen days

Twenty-one days



PREPARATION OF COMPOST HEAPS

Before this is done your teacher will have plotted out the whole area for a garden, and you will have helped him to mark it out.
See pages 10 and 11, and 14 and 15.

The success of your school vegetable garden depends on how well the class makes these compost heaps. The sizes shown here are the smallest that would be suitable for a good garden. It is better to try a fairly small one first, and be sure that the class can keep it going well.

Keep a diary record of the dates when the class starts the heap, when it is finished, when it is turned and so on.

Materials for compost are:

- Any green leaves, vegetables, etc., and any type of vegetation that will rot quickly.
- Old compost material and animal manure.
- Wood ash from burning the hard parts of plants.
- Soil. (The top of the heap as it grows should be kept covered.)

Old compost or animal manure contains certain BACTERIA. (You will learn about these small living things, invisible to the ordinary eye, later in this Course.) These bacteria break up the material, and in doing so make it hot. A stake pushed into the top or side of the heap is used for testing. After four or five days the stake should feel quite hot when you take it out.

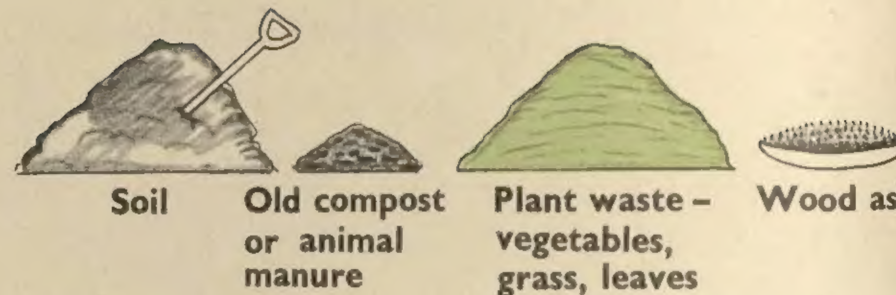
If it has not become hot, then the compost is not properly formed and will be useless. Leave it and test again with the stake after four days. If it is hot, leave it ten more days then turn it over. Repeat this as shown in the picture until it is all turned over. The completed compost must be left for a month or longer if possible before being used. Completed compost is moist, crumbly and dark brown or black. If it is not left long enough, then the bacteria may still be working and the compost will heat up and burn the roots of the plants on which you put it.

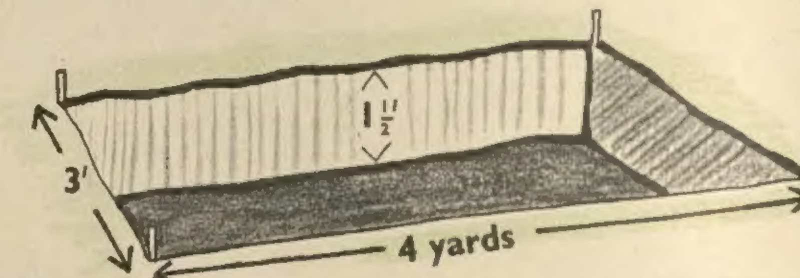
Heaps must be kept moist. Water them when turning them if it is the dry season. No watering is required in the wet season, as the heaps should not be too wet.

The rules are:

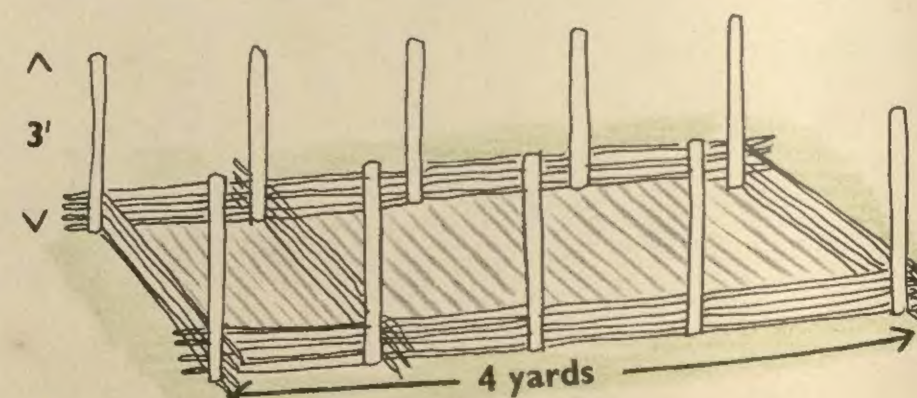
- Not enough water will prevent the bacteria from working.
- Too much water will ruin the compost.
- Never use new compost on crops.
- Always keep the compost under cover (grass, soil, etc.) even while you are making the heaps.

The books, *Rural Science for Tropical Schools* by T. M. Greensill, will provide the class with more instructions and information.



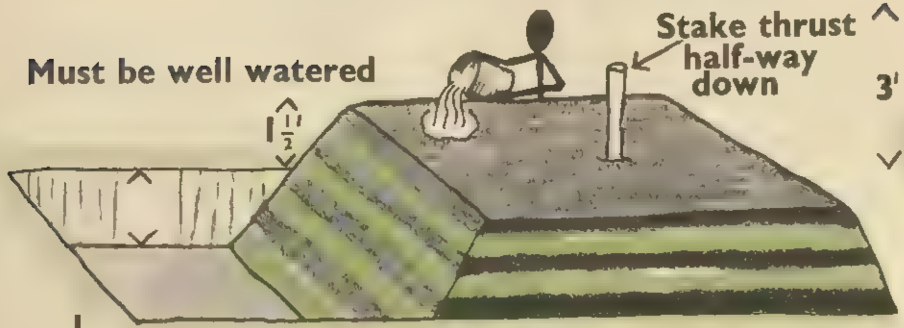


Dry Season



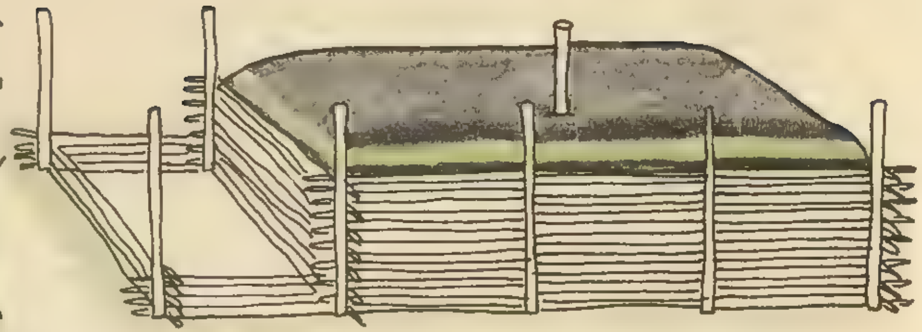
Wet Season

DRY SEASON COMPOST HEAP

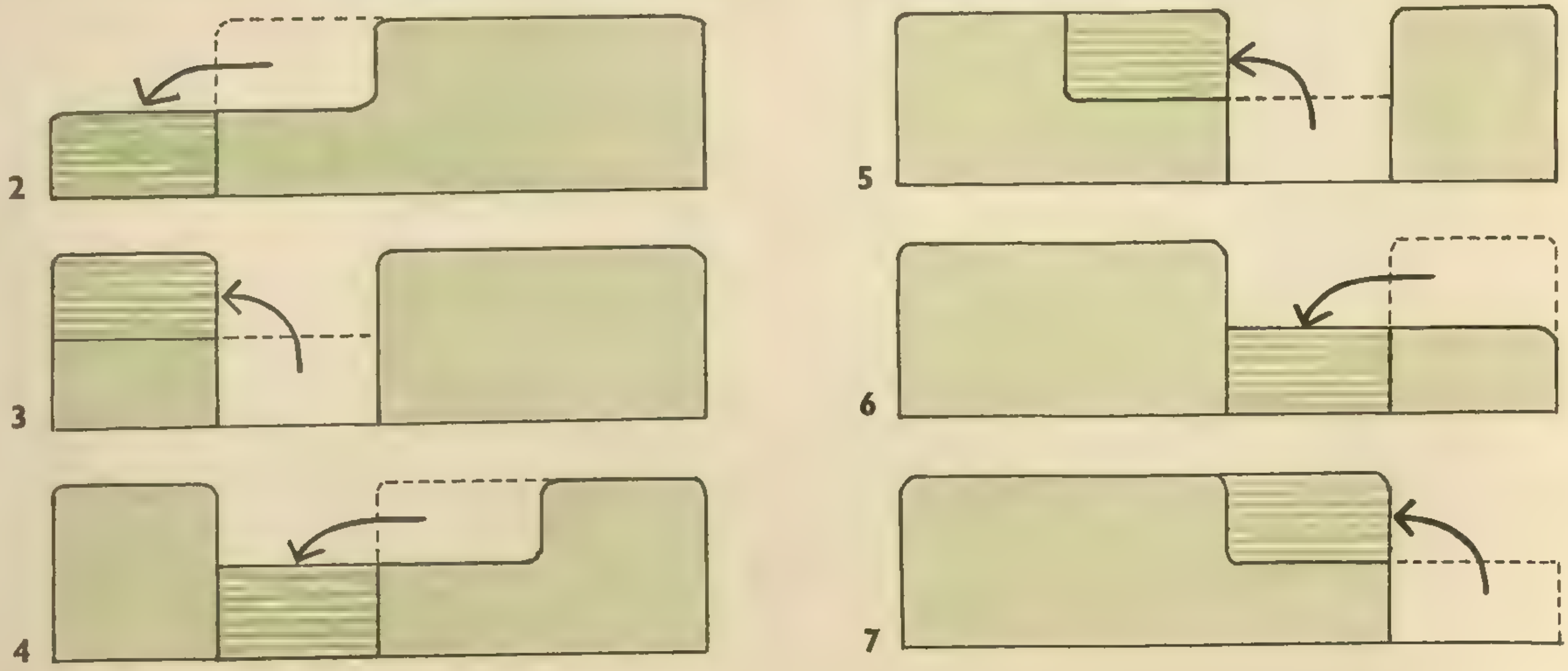


1

WET SEASON HEAP



Diagrams 2-7 show how to turn compost in either heap



PLANNING THE LAND FOR CULTIVATION

Your teacher will adapt this sort of plan to the land available. Do not attempt a big area. Choose a piece of land close to the school, even when the best soil is all swept away do not go far. A year or two of thorough composting by a class can change a barren piece of worn land to a rich plot again. Each class should do this with at least one bed on very worn-out soil as a demonstration and experiment to show to others.

The Senior Vegetable Garden shows only five years of arrangements of the crops. Draw a diagram showing what the sixth year should be like.

Your notebook should contain a map of the school garden. On it you can write the dates of digging, planting and harvesting, with the names of the crops that are grown.

There is one very important thing that must be made clear. There are a lot of mistaken ideas about the rotation of crops, and this modern kind of rotation is not necessarily the best. Usually the most economical results from the land are obtained by what you may call the old fashioned way of farming – clearing a portion of the bush, burning off at the RIGHT time, and planting for one or two seasons only, and then going on to an entirely fresh plot that may not have been used for a long time. It is rotation of land instead of crops.

Soil in cooler lands such as Europe stores up most of the 'reserve plant food IN the soil itself. In tropical countries a large portion of the 'reserve' plant food can only be preserved ABOVE the ground in the form of bush plants, and is made available for the next crop by cutting and burning. Only a little 'reserve' plant food is stored from season to season in the soil itself in countries like this.

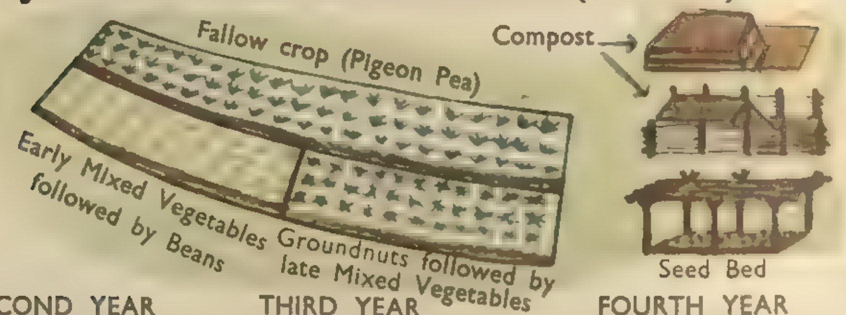
One way of farming is not BETTER than the other. Each way suits best the climate in which it is practised. The only place here where rotation of crops should be used is where land is scarce. This may happen near your school, and if the rotation is done carefully the crop will not be disappointing, though to be as good as the local farmer's crop you will have to add fertilisers to the soil. This is why your compost heap is so important.

So do not neglect a knowledge of the farmer's way, because this is the chief successful method for nearly all crops in the tropics.

If time is limited it is better to spend it in restoring a small plot near the school, and, instead of working on a complete modern rotation type farm of your own, to spend the rest of the time watching and helping the local farmers. Your teacher may organise this for you, and set you a number of things to find out each week and note down in your book.

The books *Rural Science for Tropical Schools* by T. M. Greensill, will provide the class with more complete instructions and information.

JUNIOR VEGETABLE GARDEN (FORM I)



SECOND YEAR

E.M.V., etc.	G'nuts, etc.
Fallow	

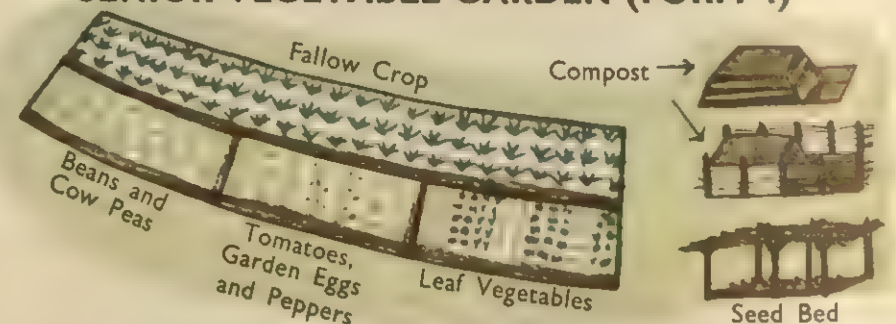
THIRD YEAR

Fallow	
G'nuts, etc.	E.M.V., etc.

FOURTH YEAR

G'nuts, etc.	E.M.V., etc.
Fallow	

SENIOR VEGETABLE GARDEN (FORM 4)



SECOND YEAR

Beans, etc.	Tomatoes, etc.	Leaf Vegs.
Fallow		

THIRD YEAR

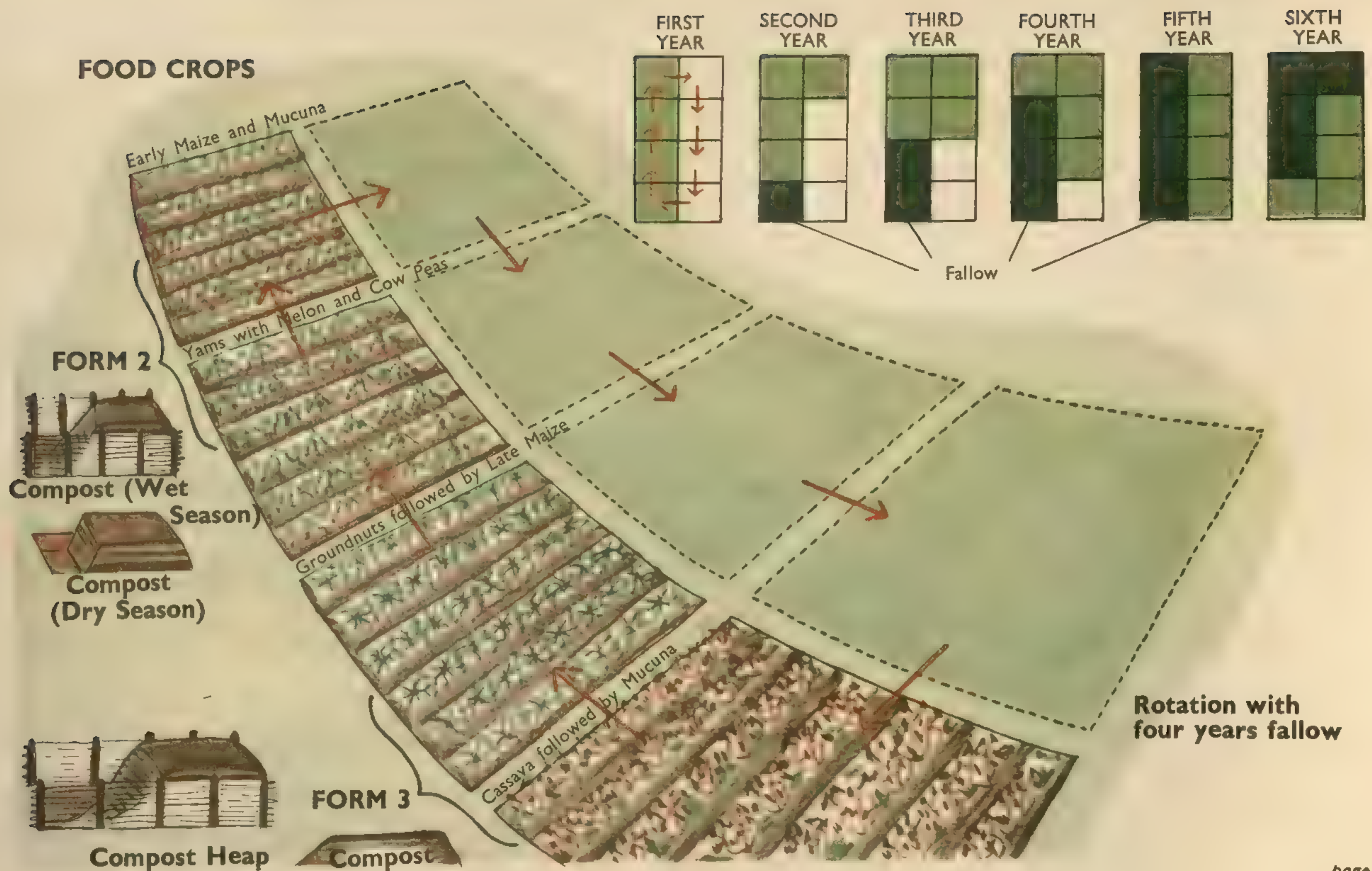
Fallow		
Tomatoes, etc.	Leaf Vegs.	Beans, etc.

FOURTH YEAR

Tomatoes, etc.	Leaf Vegs.	Beans, etc.
Fallow		

FIFTH YEAR

Fallow		
Leaf Vegs.	Beans, etc.	Tomatoes, etc.



FOOD CROPS
FIRST YEAR
SECOND YEAR
THIRD YEAR
FOURTH YEAR
FIFTH YEAR
SIXTH YEAR
Fallow
Early Maize and Mucuna
Yams with Melon and Cow Peas
Groundnuts followed by Late Maize
Cassava followed by Mucuna
FORM 2
Compost (Wet Season)
Compost (Dry Season)
FORM 3
Compost Heap
Compost
Rotation with four years fallow

Why does the box of seeds have to stand on pieces of wood in tins filled with kerosene? Write down your answer.

Most vegetable seeds can be obtained locally. If they have to be kept for long, they should be kept in a bottle which can be sealed up as shown on page 12. It is the moisture in the air which rots the seeds, and unslaked lime is put with them to dry up the air. The mosquito netting is to keep the seeds from touching the lime.

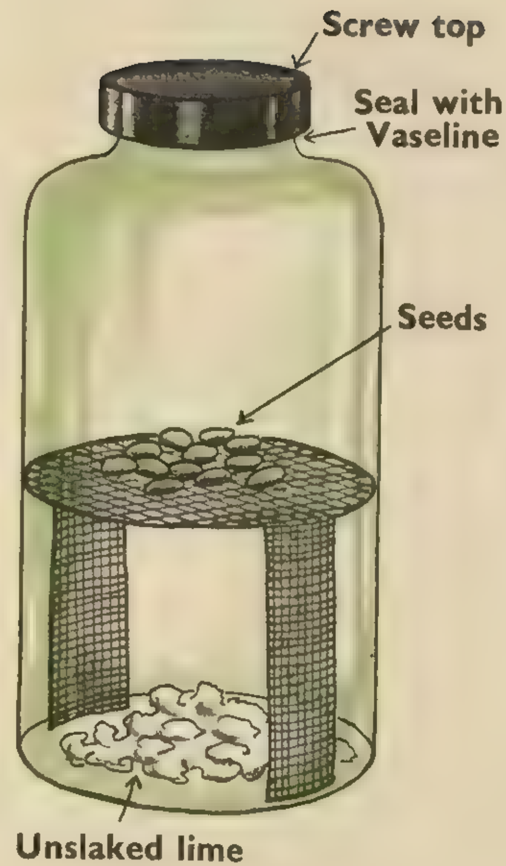
The pictures explain themselves. Do not cover the boxes so thickly with leaves that no sunlight at all can filter through. The same applies even more to the Seed Bed. Only a limited amount of leaves or bamboo is needed, as sunlight must be able to come through. The leaves are only to reduce the amount of sunlight, not to shut it out altogether.

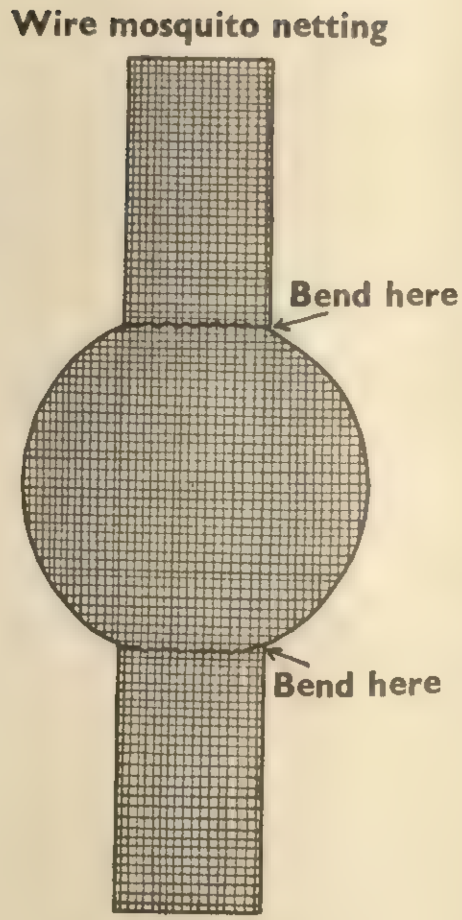
In your Nature Diary note the following things:

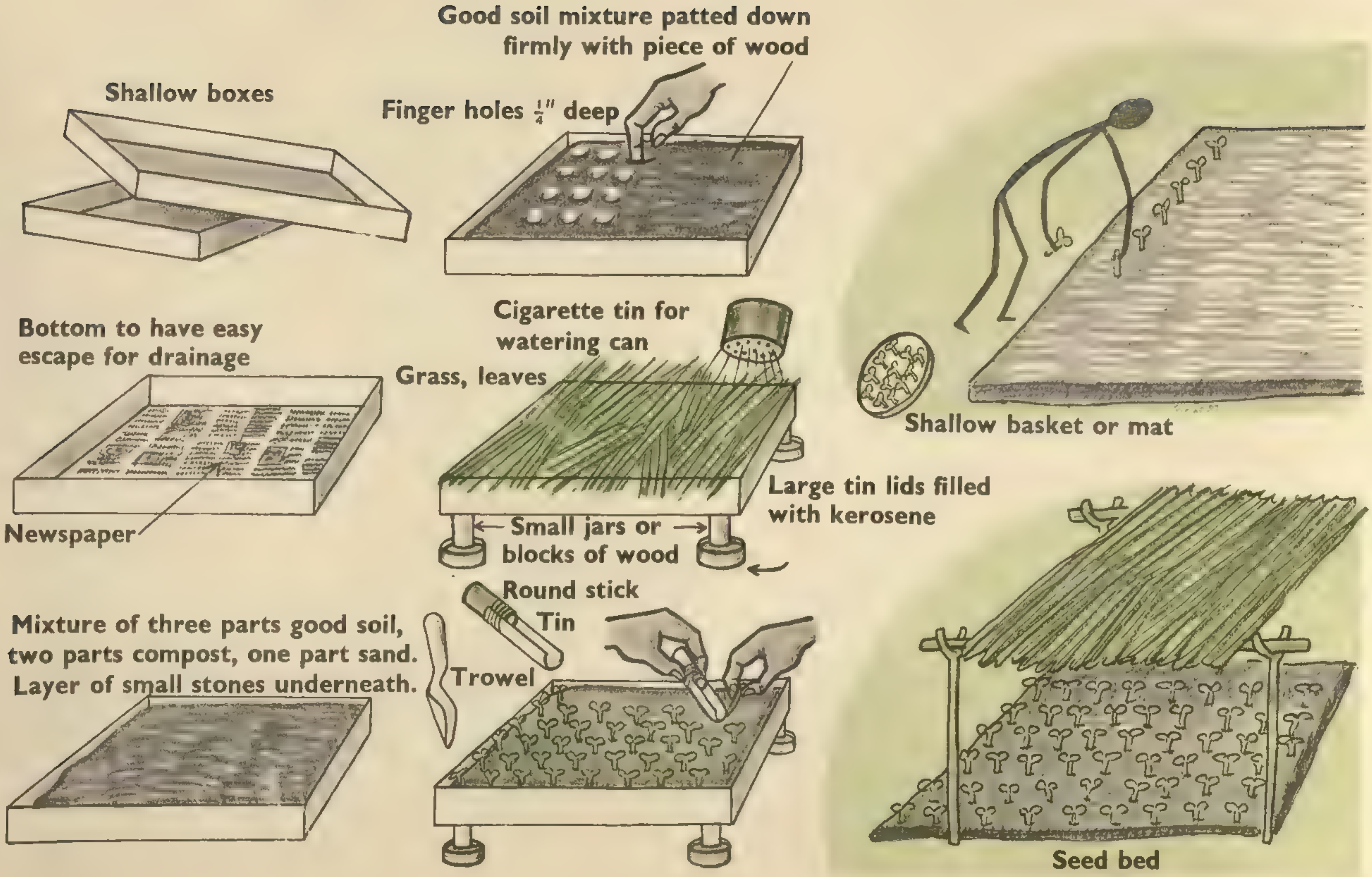
1. The type of seed set in the boxes.
2. The number of seeds in each box.
3. The seeds are ... inches apart.
4. The date of planting the seeds.
5. When the seedlings have grown enough to transplant to the Seed Bed, count the number and note the date on which you move them.
6. Do the same as 4 when you move them from the Seed Bed to the Vegetable Plot.

There are a great many details which vary from place to place, and with different kinds of vegetables. Your teacher will fill in these important facts and help you to make notes of them.

The most valuable people from whom to get more knowledge of all this are the local farmers. See how much you can find out. Discuss it with your teacher, then add what you have found to the notes in your book.






Good soil mixture patted down firmly with piece of wood
Shallow boxes
Finger holes $\frac{1}{4}$" deep
Bottom to have easy escape for drainage
Newspaper
Cigarette tin for watering can
Grass, leaves
Shallow basket or mat
Large tin lids filled with kerosene
Small jars or blocks of wood
Round stick
Tin
Mixture of three parts good soil, two parts compost, one part sand. Layer of small stones underneath.
Trowel
Seed bed

PREPARATION FOR A VEGETABLE PLOT

The measurements are a minimum for one class. Do not dig more plots than the class can keep supplied with compost.

Draw a map of the school plots.

Keep a diary of all your work on the plots – dates of digging, seeding, harvesting, etc.

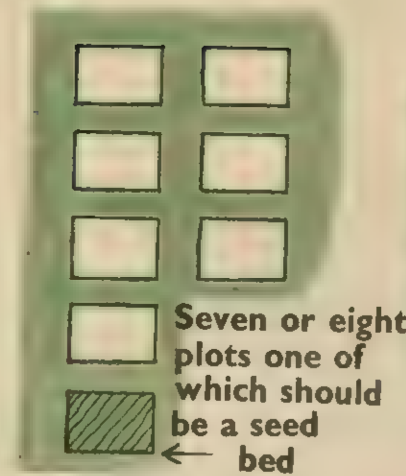
The best vegetable plot is one that is prepared like this on a new piece of cleared land. Soil around many schools has become very poor, and the good top soil with food for plants has been worn away.

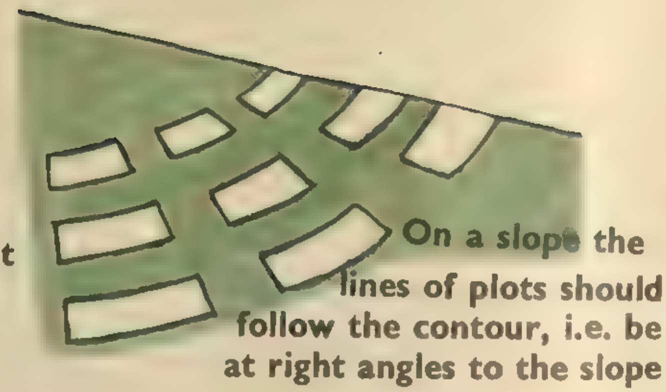
A small plot up to 200 square feet near to the school is far more useful for some things than a large plot a long way off. Besides which, there is so much land already destroyed in many parts of Africa, that some of the most important things you can learn are ways of getting good soil back on the land and keeping it there.

So although there may be good land at a distance, at least one section of the class should have a compost heap and small plot on the school compound itself. This experiment you will find very worth while, and people round about will be surprised and interested to see that such a plot can be farmed successfully.

The rest of the class can make their vegetable plot on fairly good soil, and will not have to use as much compost on their plots. The exact way in which all this is carried out will be decided by your teacher to fit in with the local conditions.

The books, *Rural Science for Tropical Schools* by T. M. Greensill, will provide the class with more complete instructions and information.

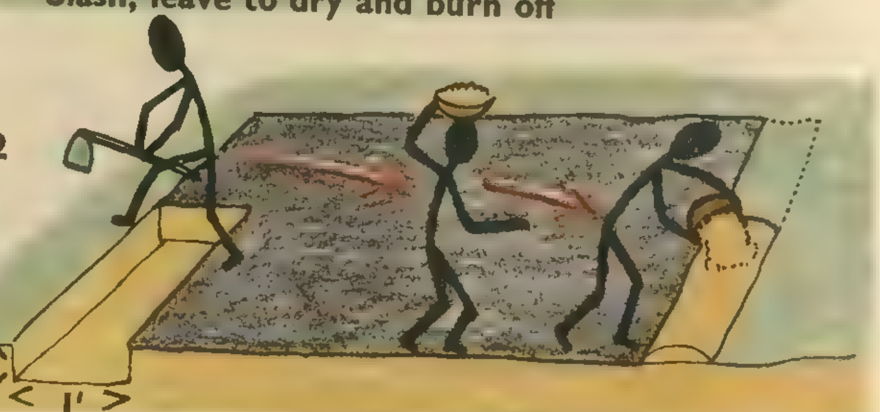


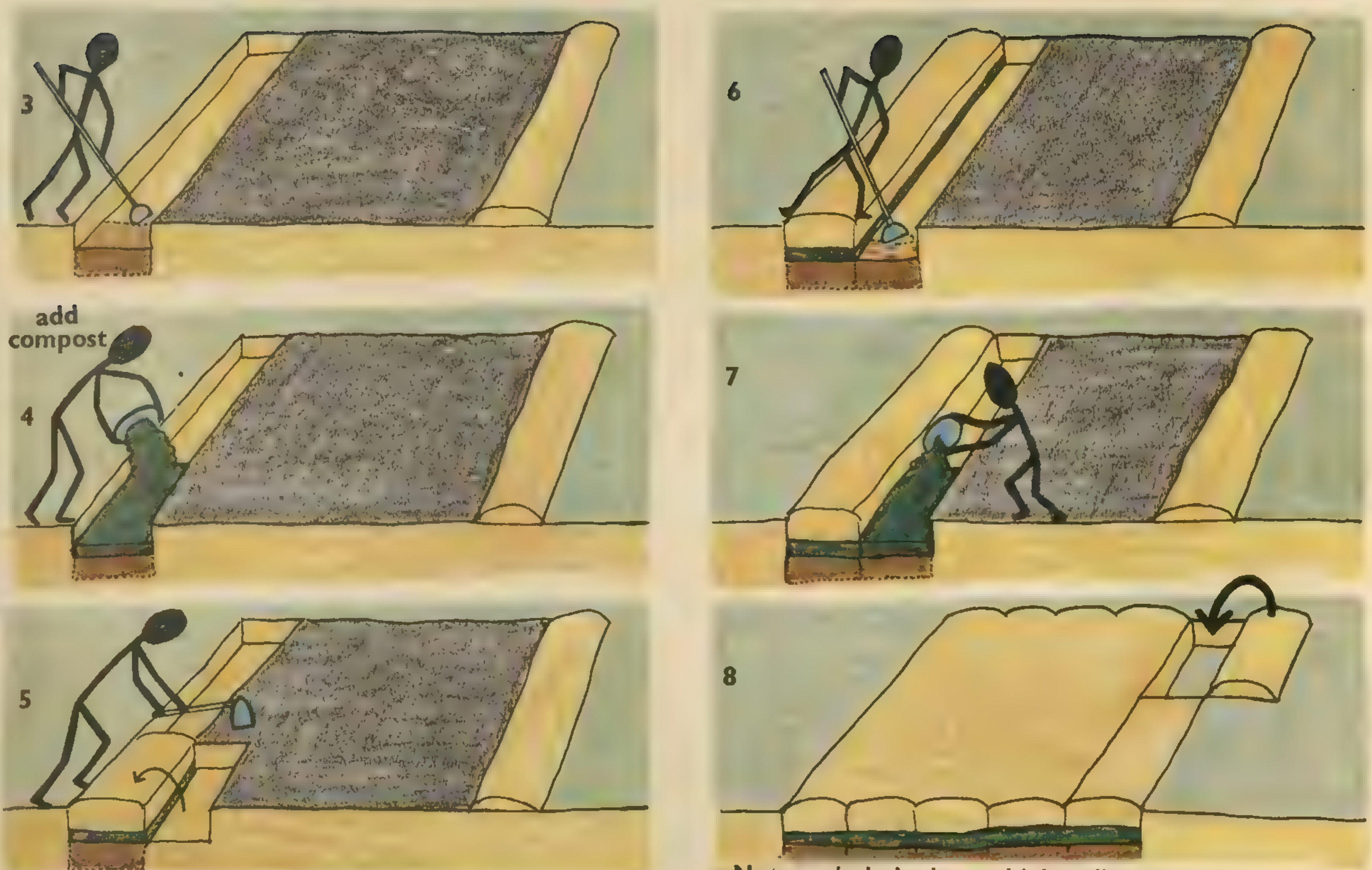


1

Slash, leave to dry and burn off

2





Note : whole bed now higher (important)

If you have enough jars these experiments can be done individually or in pairs.

There is nearly always water under the ground. The level at which the water can be found under the ground is called the 'water table'. Water will go through some types of soil and even rock, but will not go through others. It will not go through glass, for example. We say therefore that glass is 'impermeable'.

2 and 3 help you to understand what is meant by a water table. The cut-in-half picture of a 'water hole' shows what it is like in real life.

4. Now add more water and you have a swamp. Notice that the water will not go through the glass.

5. When the water is very deep down we have a desert.

6 and 7. Water will not go through clay either. Try 6, and then draw 7 to show what happens.

Under the ground some of the layers of soil or rock are permeable and some are impermeable.

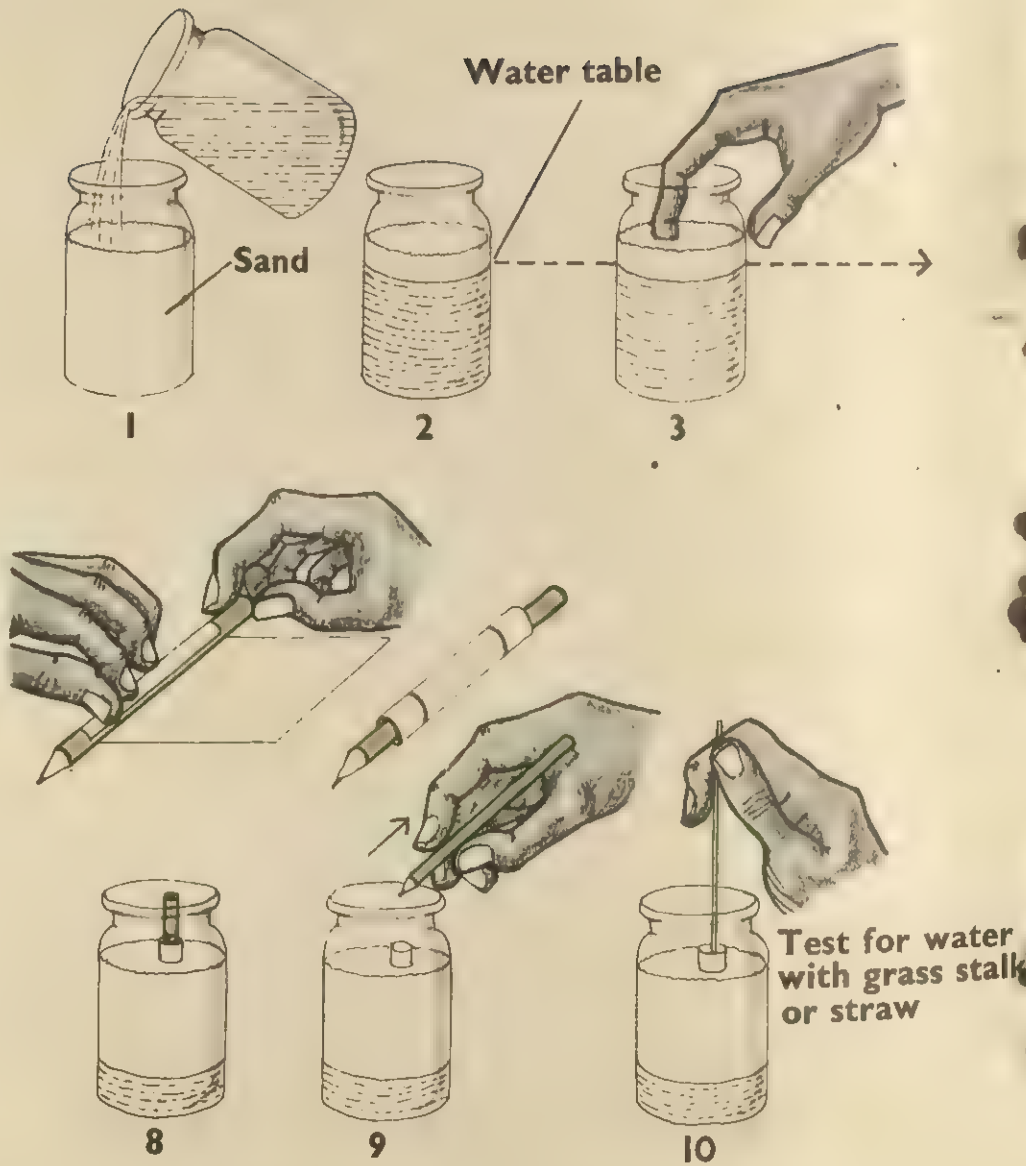
8, 9 and 10 show a simple way to make a well. Do this.

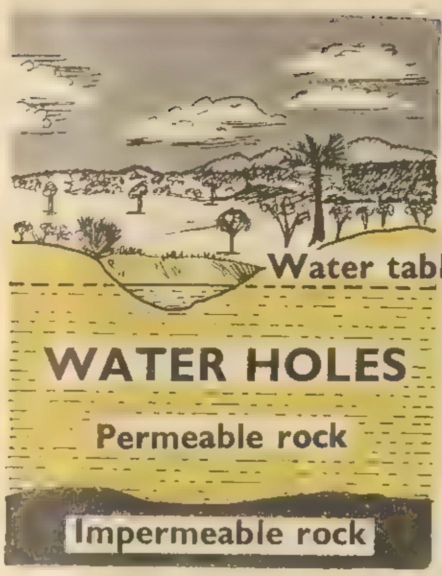
See if you can understand the last two pictures. Sometimes the boring for a well has to go through impermeable rock first before it can get to the water. When this happens and the water table is higher in the country nearby, you may get an 'artesian well' when the water will come up of its own accord like a fountain, once you have made a hole through the impermeable rock.

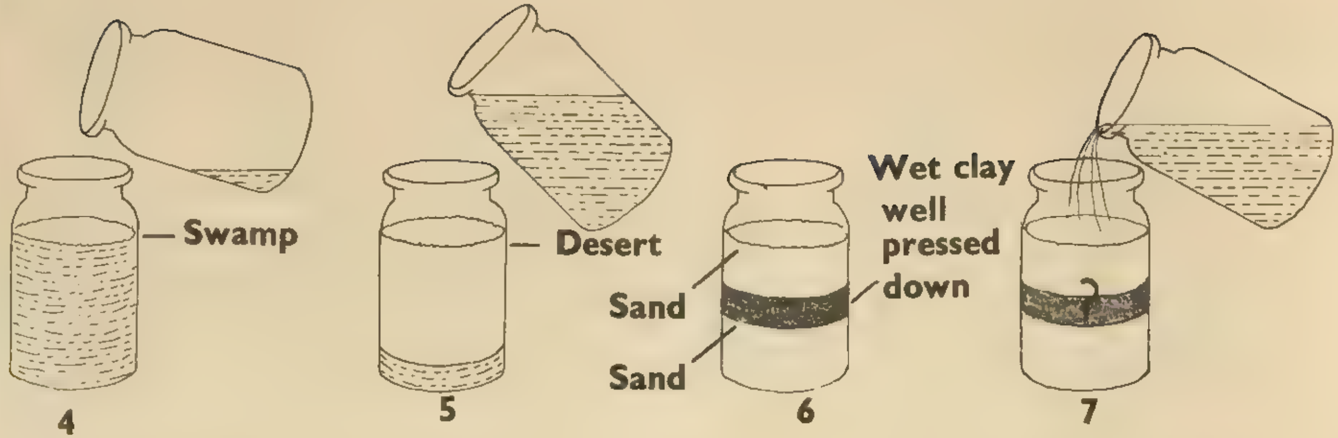
Write a short account of what you did in experiments 1–10.

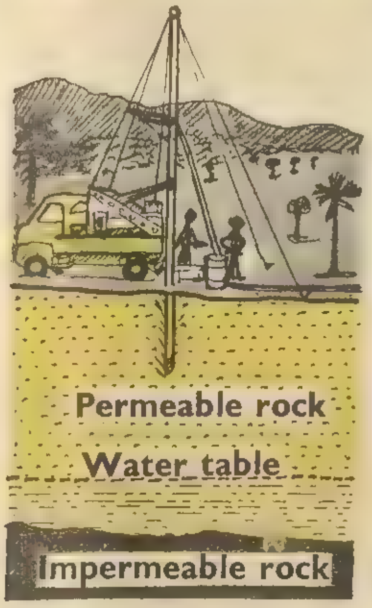
Oil wells work in the same way. We shall learn more about these later in another book.

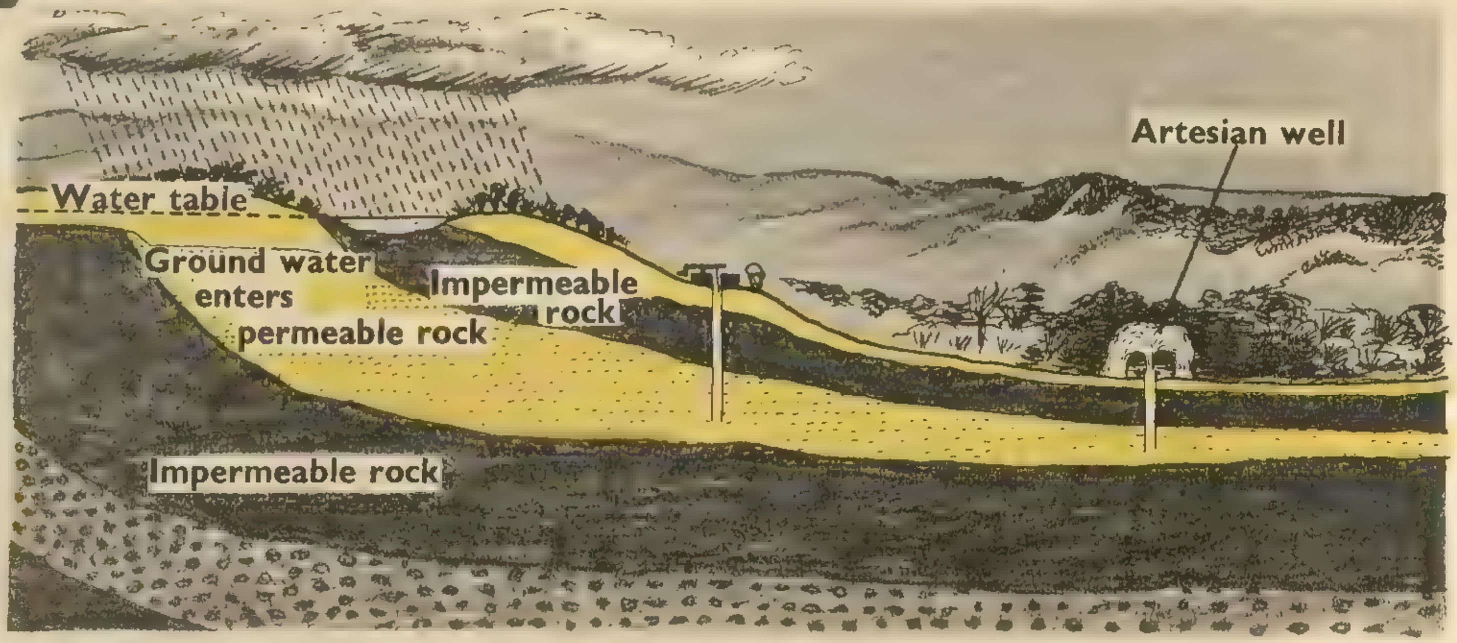
Note. Very coarse sand, or better still gravel, is needed for these experiments.




Water table
WATER HOLES
Permeable rock
Impermeable rock


Swamp
4
Desert
5
Sand
Sand
Wet clay well pressed down
6
7


Permeable rock
Water table
Impermeable rock


Artesian well
Water table
Ground water enters permeable rock
Impermeable rock
Impermeable rock

DAY AND NIGHT

This demonstration is best done with some of the light shut off from the classroom, and everybody standing round the sides of the room. If there is no globe, your teacher will draw an outline of the world map on a football. The mark for the position of your own country can be made by a matchstick stuck on with wax or chewing-gum or something else sticky. The North and South Poles should also be marked.

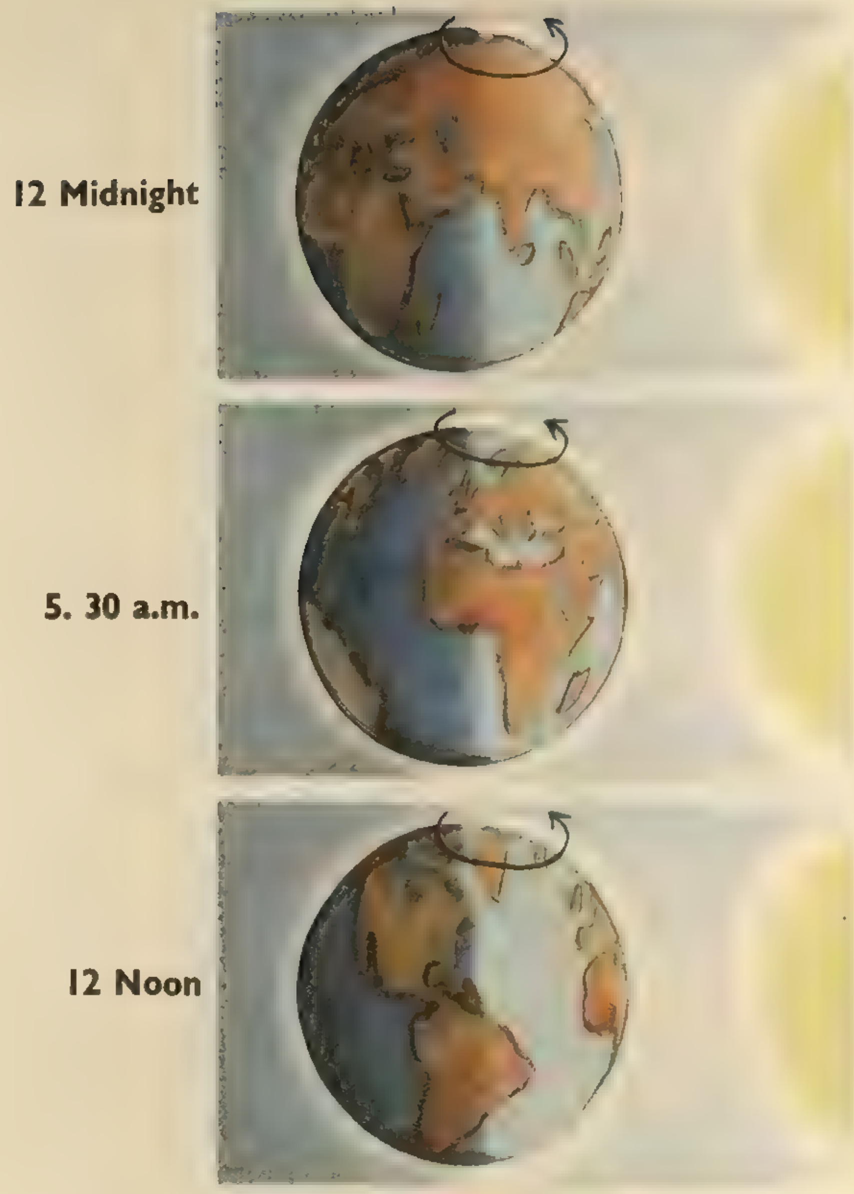
Notice that the earth turns round at an angle to the sun. Imagine a rod going through the earth, and the earth spinning round on it. This rod would not be standing upright, but would be sloping slightly. This is what causes a great variation of climate in different parts of the year in the countries nearer the North and South Poles.

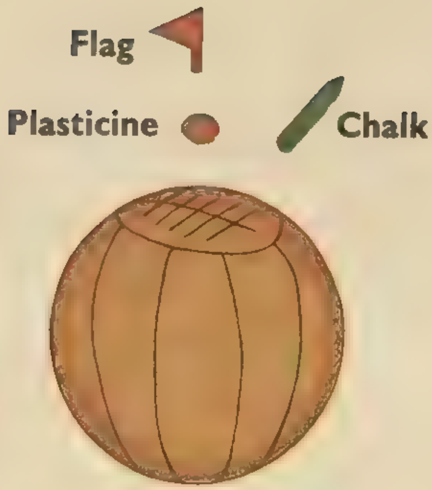
Write down as many reasons as you can think of that make people realise that the earth is round and not flat.

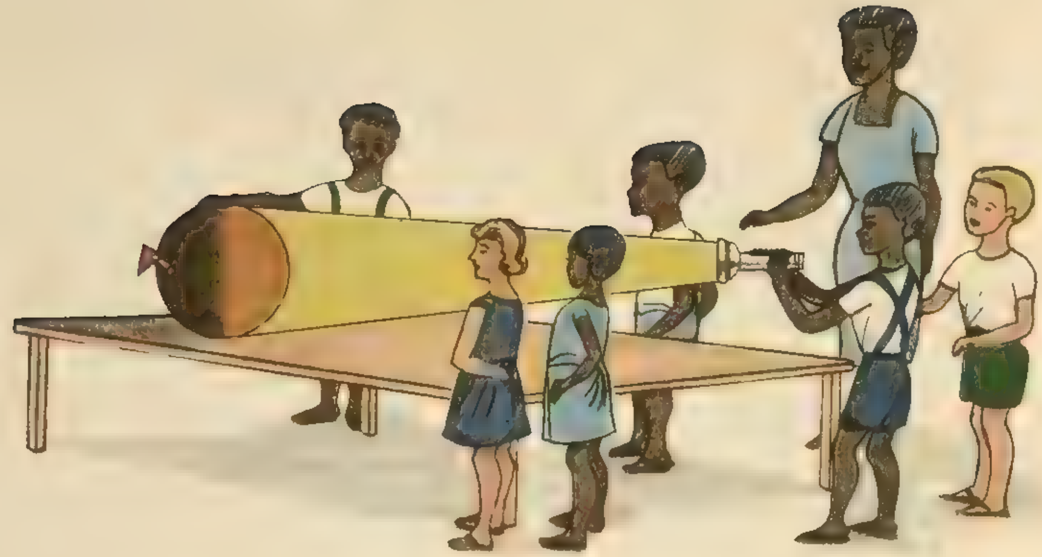
How long does it take the earth to spin round once?
Why does the sun appear to cross the sky and then disappear?
Why do the stars appear to move very slowly across the sky?
Which way does the earth turn round? Towards the east or the west?
Are sunrise and sunset at the same time all the year round?

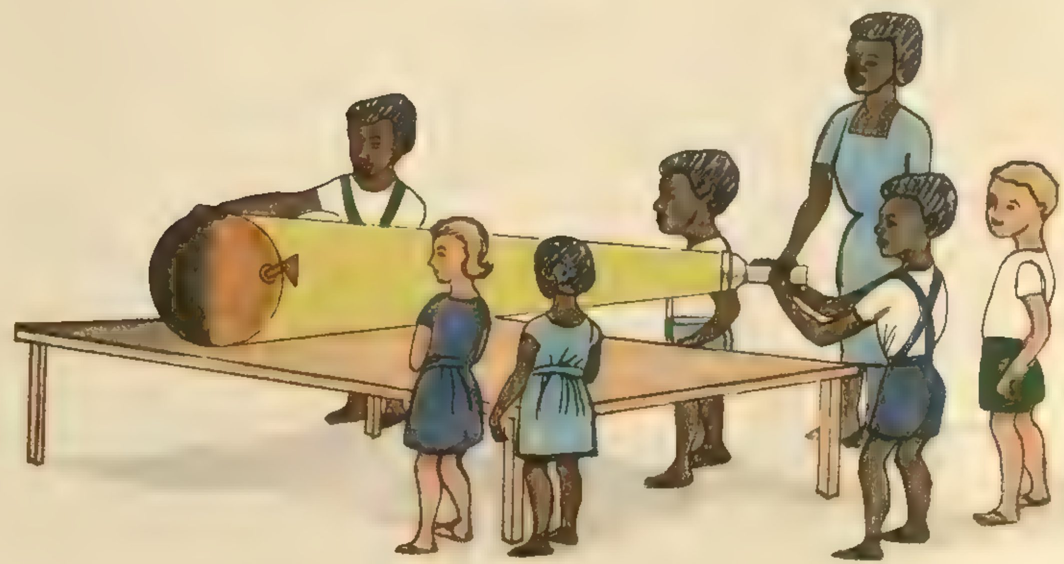
Write the answers to these questions in your Nature Book.

Draw two pictures to show the position of light and darkness on the earth at 9 a.m. and 9 p.m.




Flag
Plasticine
Chalk





LIGHT AND SHADE

Materials Required: Match boxes, pencils, cards, torches, beads, wire and drawing pins.

1. Work in groups. Note there are two kinds of shadow. Move the pencil farther away and then nearer to the card. Now write down all the differences made by doing this.

2 shows you a picture of how the earth spins round itself once a day. It also travels in a circle round the sun once a year. At the same time the moon is travelling round the earth once in 28 days. So they are all moving.

3. The whole class can help with this. Using a long piece of string, make a big circle of 60 yards radius. You will need to find a large piece of ground to do this. The 'moon' may be held to the 'earth' by a piece of string 5 yards long. The 'earth' steps slowly forward round the big circle. At each step 'earth' turns the umbrella round once to show 'earth' is spinning round as well as moving forward. For every turn of the umbrella (this is one day) the 'moon' also takes a step round the 'earth', keeping the 5 yard string tight. After he has taken 28 steps, the 'moon' should have gone round 'earth' once.

Answer the following questions in your book:

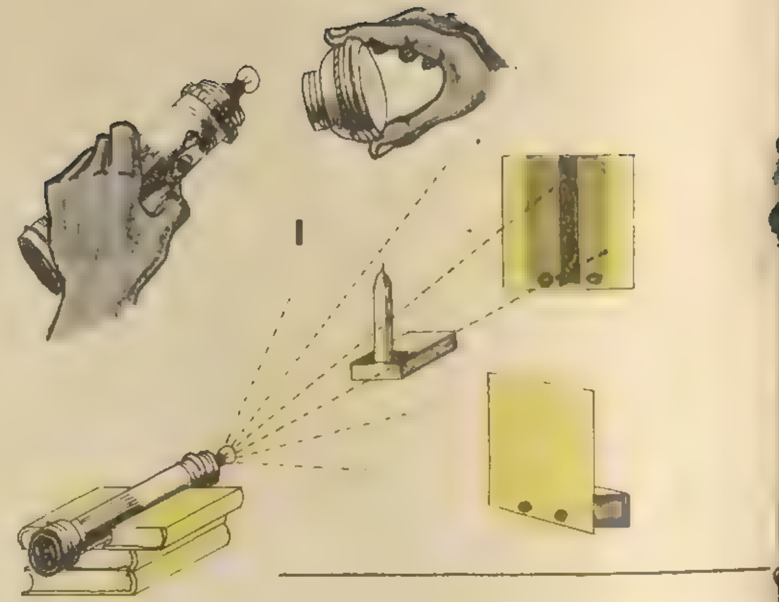
How many times does the moon go round the earth in one year?

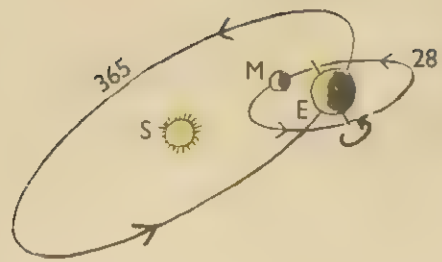
How many days of the year are left over?

What is the difference between a calendar month and a lunar or moon month?

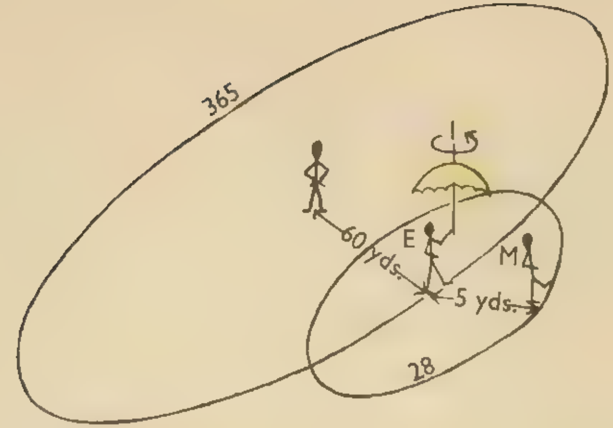
4. Groups can set this up on the floor on newspapers, using the darkest side of the classroom.

5. Move the bead into the positions shown in the diagram. Notice specially when the shadow of the moon hits the earth. This causes an 'eclipse' of the sun, that is a hiding of the sun in that part of the earth. Write an answer to the question, what is an 'eclipse' of the sun?

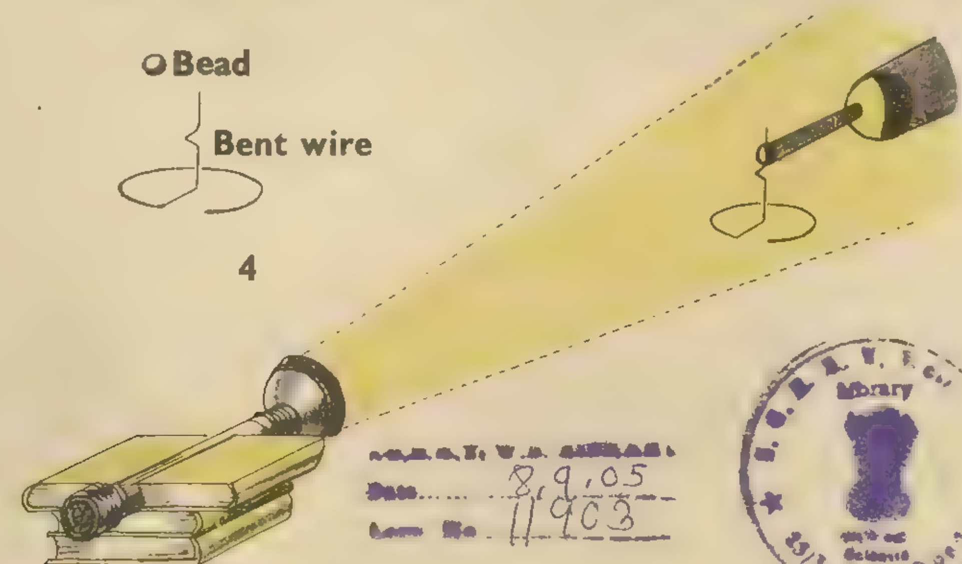



365
M
28
E
S

2

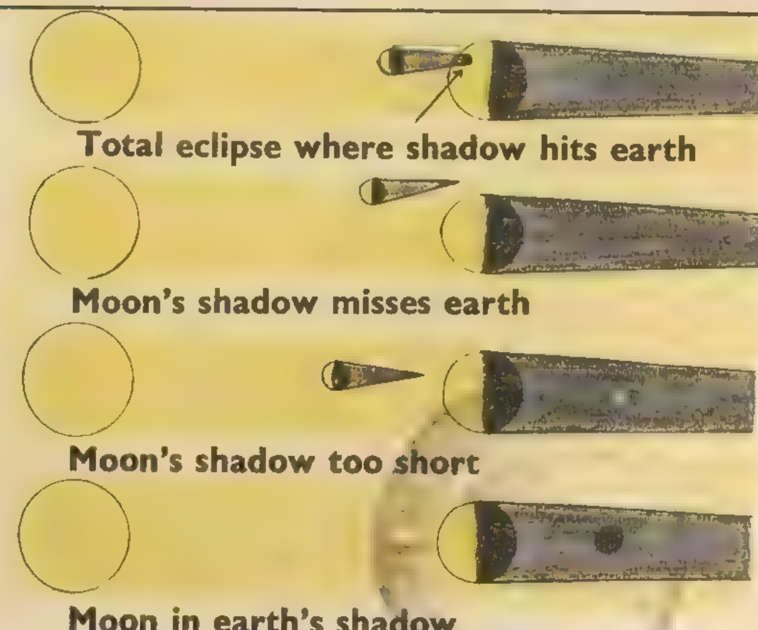

365
60 yds.
E
M
5 yds.
28

3


Bead
Bent wire

4

5


Total eclipse where shadow hits earth
Moon's shadow misses earth
Moon's shadow too short
Moon in earth's shadow

REFLECTION

A1 and 2. One or two pressure lamps will enable all groups to use them without moving from your places. Why can you not see the light through the bent roll of paper, or when the cards are out of line?

A3. Light 'bounces' too. Watch how a ball bounces.

A4. The white page will reflect light from outside on to your partner's face, if he sits with his back to the window. Try it.

B1. Light travels in straight lines to your eyes when you see the picture of your partner in a mirror like this. Try it.

B2. Hold a mirror so that you can see round a door or over a desk without being seen yourself.

B3, 4, 5 and 6. These are to be done in groups, each near a window or outside a room. 6. One from each group draws on the bottom of the box the path of the light. Measure angles O and P, and angles X and Y. Make a drawing in your book of the path, and put in the angle measurements. Now describe exactly how light changes direction when it hits a flat surface.

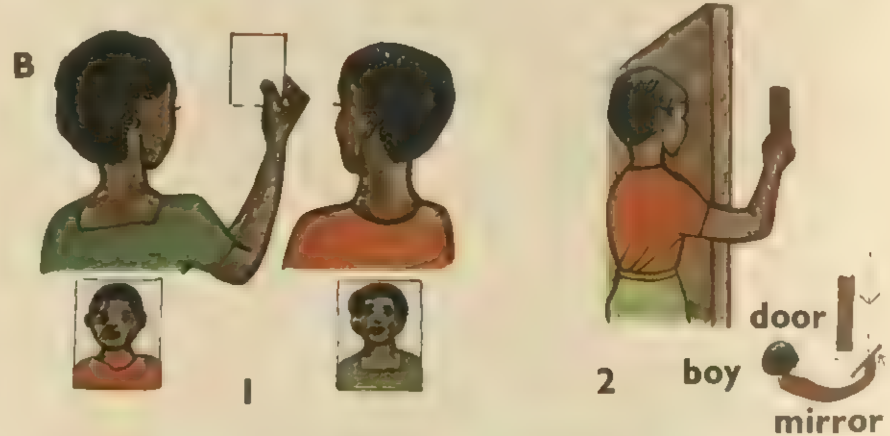
Some surfaces reflect better than others. Make a list of good reflecting materials, and another list of poor reflecting materials.

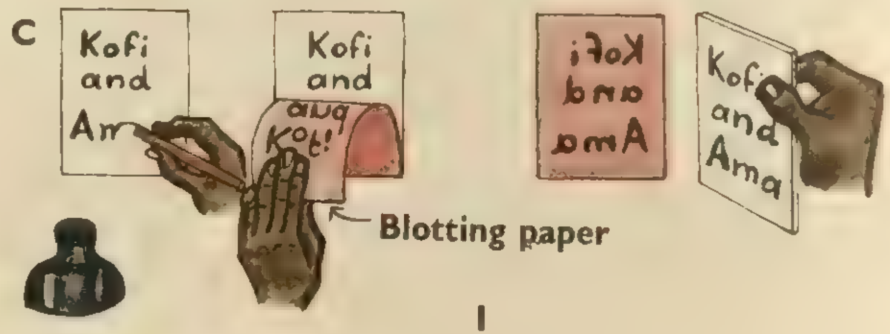
C1. Write with plenty of ink, or even use a small paint brush. Blot it quickly and carefully. Hold a mirror to the blotting paper. Write down what you have done and what you have found out.

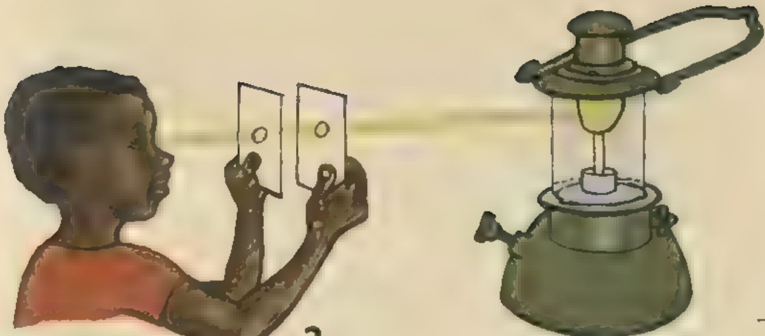
C2. These are two mirrors at right angles, and one coin.

C3. This is another way to show how light is reflected, and it is to be done in groups. The torch bulb must have no glass or reflector round it. Move the bottle until the beam of light is the same width all the way along. Choose the darkest places in the classroom to set these up.

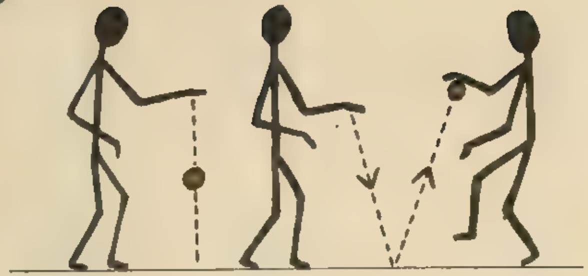
Make a drawing showing experiment 3 looked at from above (a 'plan'). Angles can be measured as in C2.





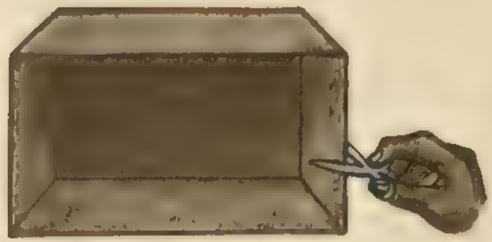


2

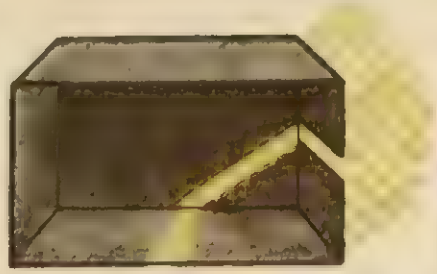


3

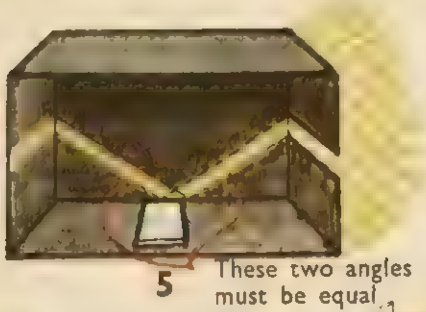
4



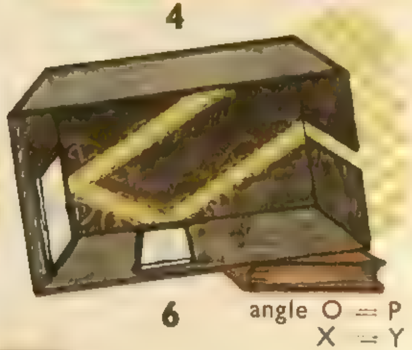
3



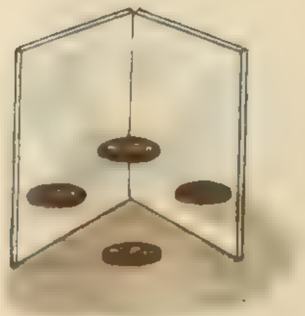
4


These two angles
must be equal

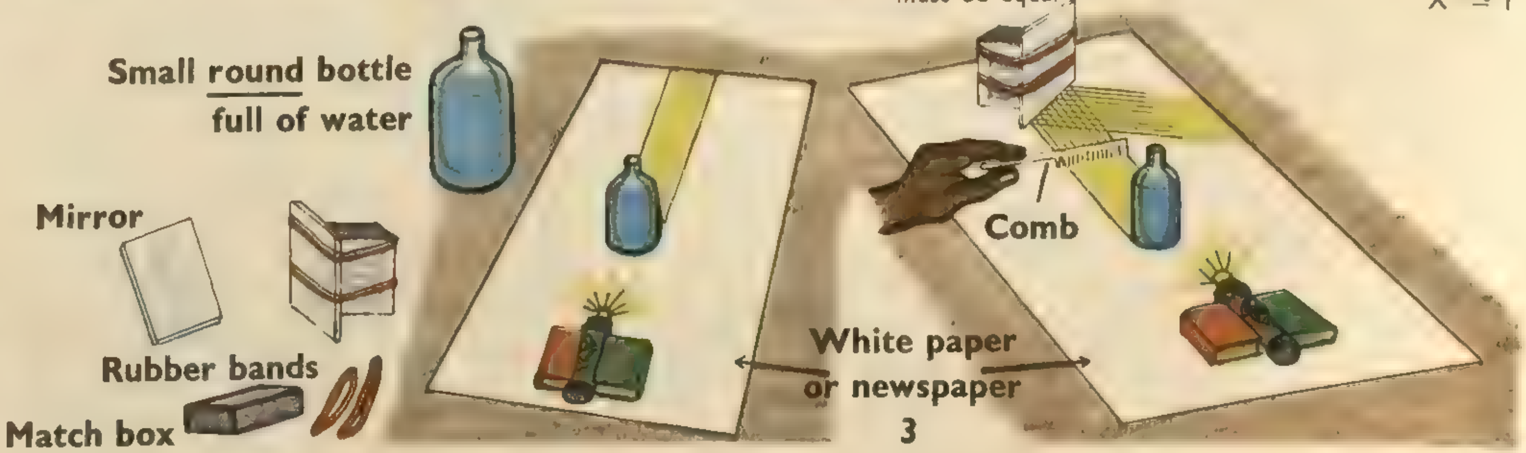
5


angle O = P
X = Y

6



2


Small round bottle
full of water
Mirror
Rubber bands
Match box
Comb
White paper
or newspaper

3

PHASES OF THE MOON

Draw 28 circles as on page 24. Your teacher will give you the date of the full moon, then you can fill in the other dates on your diagram.

Observe the moon each night if possible. When you can get a clear idea of the shape, sketch it in your book the next morning before you forget it.

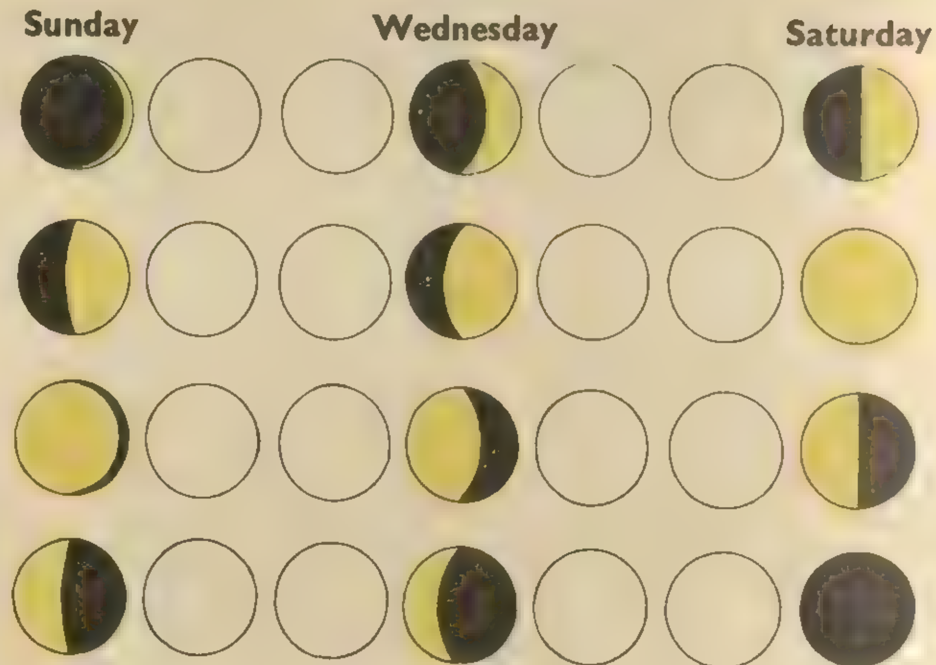
The experiment on page 25 may be done in front of the class. It will help you to see that the apparent shape of the moon is the shape of the bright part only, on which the sun is still shining, though the earth has turned so that we are already in darkness. (It is better to wait until it is dark to see the shape more clearly, though sometimes the moon can be seen during the day.)

The girl's head represents the earth, the Tilley lamp is the sun, and the ball the moon.

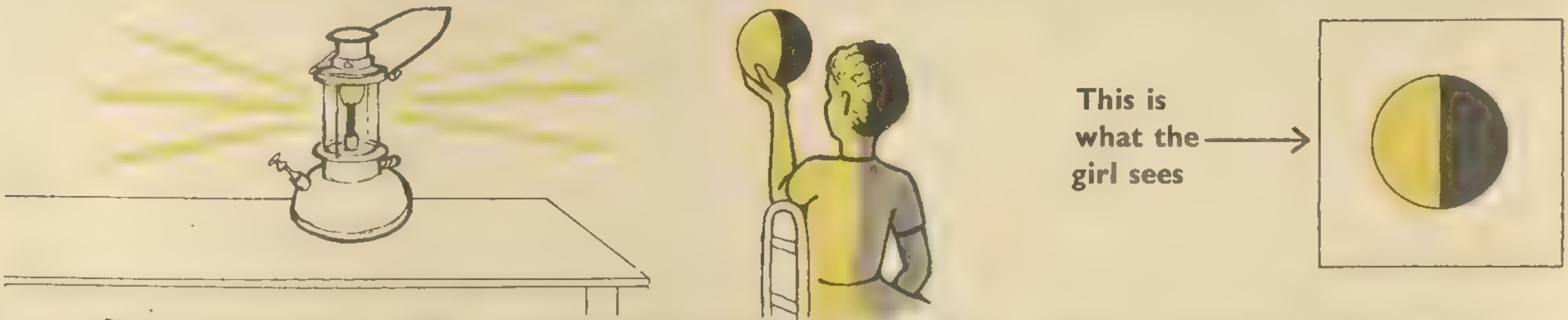
The girl's right eye represents the place on earth where the observer is standing. In the pictures you will notice that the sun never shines on it. As the ball changes position, that right eye sees the bright part of the moon in different shapes.

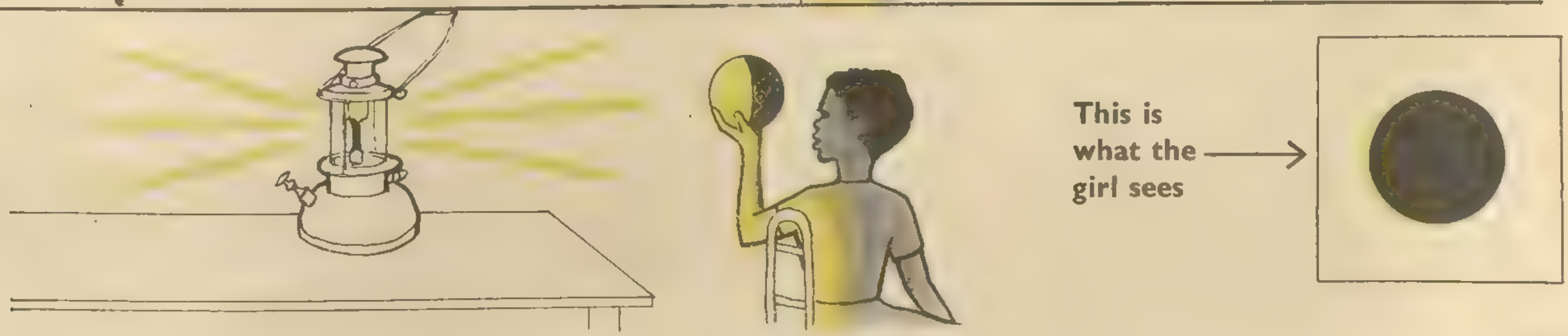
Write about six sentences explaining why the moon appears to change its shape.

Refer to page 20 to see why there are 28 days in a lunar (Moon) month and a varying number of days in a calendar month.




This is
what the
girl sees


This is
what the
girl sees


This is
what the
girl sees

SIMPLE MACHINES CALLED LEVERS

2, 3 and 4. Which is the easiest and which is the hardest way to lift the edge of the table? This will be done in front of the class, as will 5.

For 5 set down the following in your books:

> A. To lift the table 1″, Free End moves......
> B. So Free End moves......times as much as table.
> C. What is the $\frac{\text{Distance of F.E. from T.P.}}{\text{Distance of weight from T.P.}}$?

Now set down the same questions for when the table is raised 3″ and 6″. Fill in the answers as this is tried out in front of the class.

6, 7 and 8 are for you to work out on paper WITHOUT experiment first. Set down the questions in the same way, but start answering C first and then you will be able to find A.

What do these experiments tell you about the distances moved, compared with the distance of the Free End and weight from the Turning Point? Your teacher may help you to write a clear answer.

Some of the examples at the bottom of the page will show you that the Turning Point need not always be between the Weight and the Free End. This does not in any way alter the rule you have just made. Draw an arrangement to lift a weight easily when the Turning Point is at the *end* of the lever.

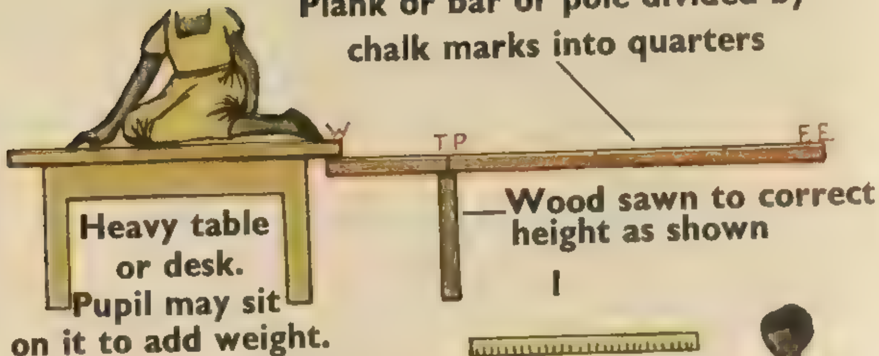
9. Set this up on your desk.

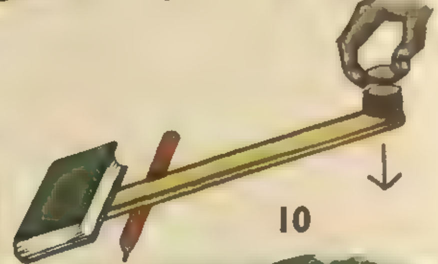
10. Instead of your finger pressing down, try putting coins on the end until the book rises. Now the WEIGHT of the coins is the same as the FORCE your finger was using. In Science, Force is often measured by Weight, like this.

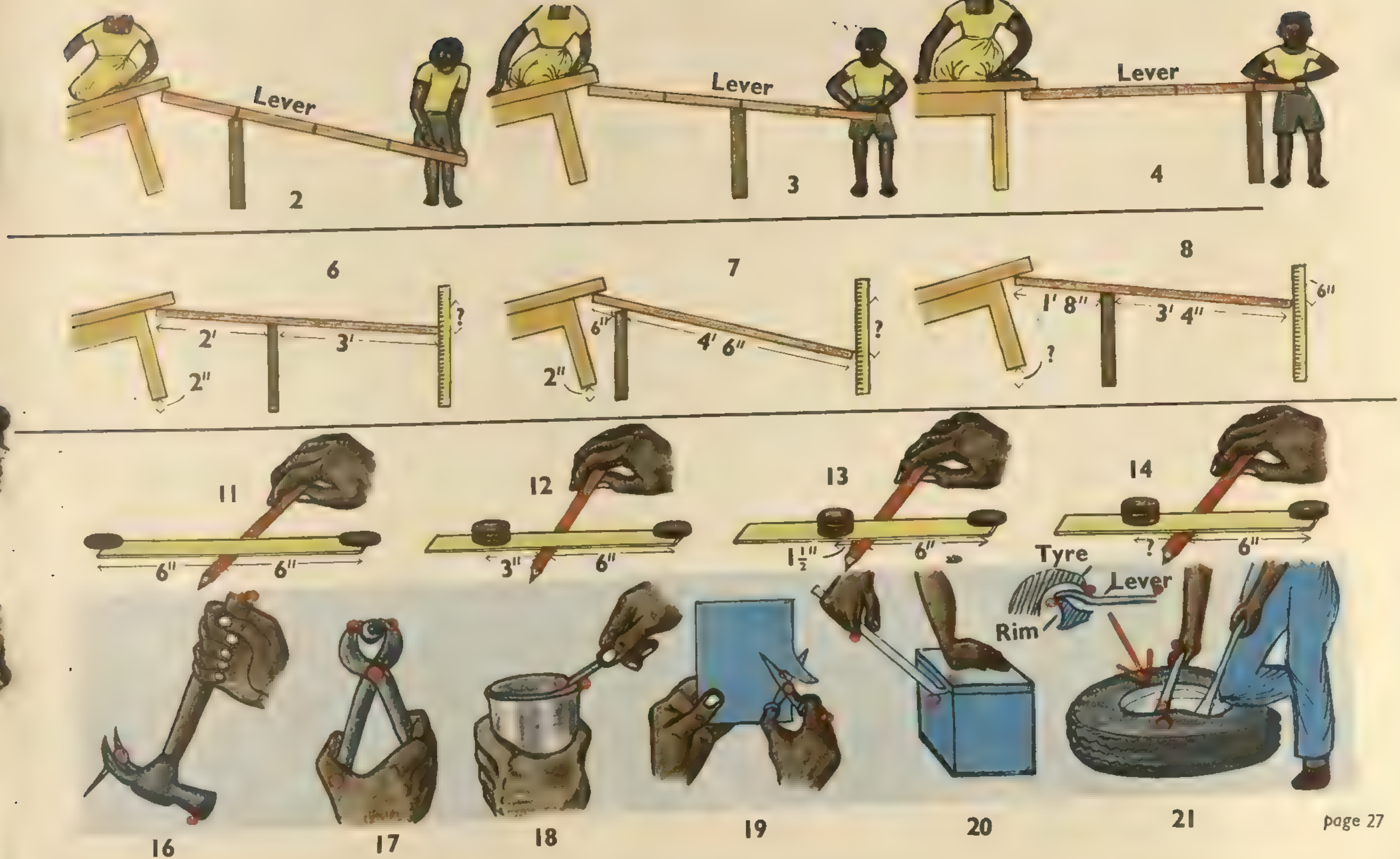
Now try 11, 12 and 13. You will discover another rule about levers. When a lever is balanced, ONE force or weight, MULTIPLIED by its distance from the Turning Point, is EQUAL to the OTHER force or weight MULTIPLIED by its distance from the SAME Turning Point. Draw picture 14, and work out the distance by this rule. When you have worked it out, test it. Were you right?

You are now beginning to use an important scientific method. If you think, after an experiment, that you have found a rule that seems to explain all that happens in your experiment, then it must be

Continued on page 28






Lever
2
Lever
3
Lever
4
6
2'
3'
?
2"
7
6"
4' 6"
?
2"
8
1' 8"
3' 4"
6"
?
11
6"
6"
12
3"
6"
13
$1\frac{1}{2}$"
6"
14
?
6"
Tyre
Lever
Rim
16
17
18
19
20
21

Continued from page 26
scientifically tested. One way of testing it is to work out on paper what would be the answers to a number of problems IF the rule were true. Then test each answer by doing it, to see if your 'theory' is correct.

This can sometimes be done using Arithmetic as we have done here.

As a learner in Science you must do this sort of thing carefully and thoroughly.

15–20 show some of the ways in which a lever is used in everyday life.

In each picture three dots mark the T.P., the Free End and the place where the weight or force is felt. Can you see which is which?

Make drawings of OTHER levers that are used, and mark in the three points and label them.

USING SLOPES AS MACHINES

Slopes are another way of making work easier. The same rules apply as with levers. The bigger the force you wish to apply at the Lifting End, the farther you will have to move the Free End of the machine.

1 to 6 may be done in front of the class.

1 and 2. It takes a long slope and a lot of pushing to raise a car 'up' a foot or two. 3 shows two methods of raising a toy car six inches. Is there any difference in the force your finger has to use to do it in each case?

In 4, 5 and 6 we are moving the slope ALONG in order to move the car 'up'. The hand holding the string does not move at all.

7, 8 and 9 you will all try for yourselves, doing the same thing another way.

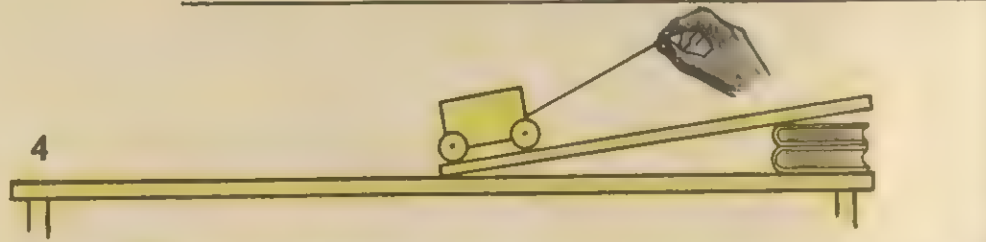
10 and 11. Coil your 'slope' round a pencil. Secure with a pin. Rest the other pencil point gently on the beginning of the slope, keep it on the slope all the time while you turn the slope round with the other hand. A coiled slope can move a weight up with great force. You are moving the slope underneath the weight as in 4–9.

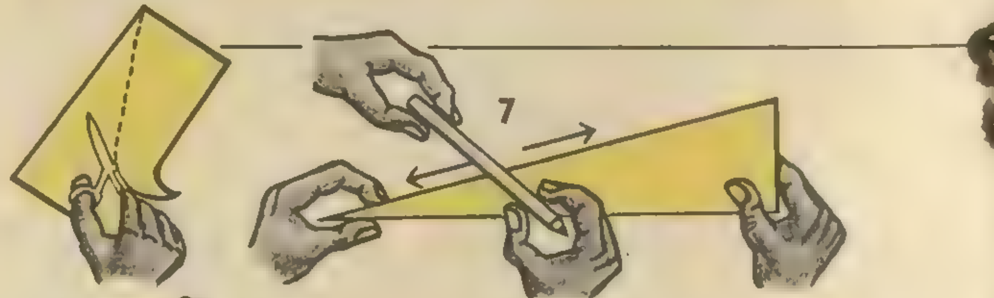
12. This is the way a car-jack works. Your teacher may be able to demonstrate this with a car.

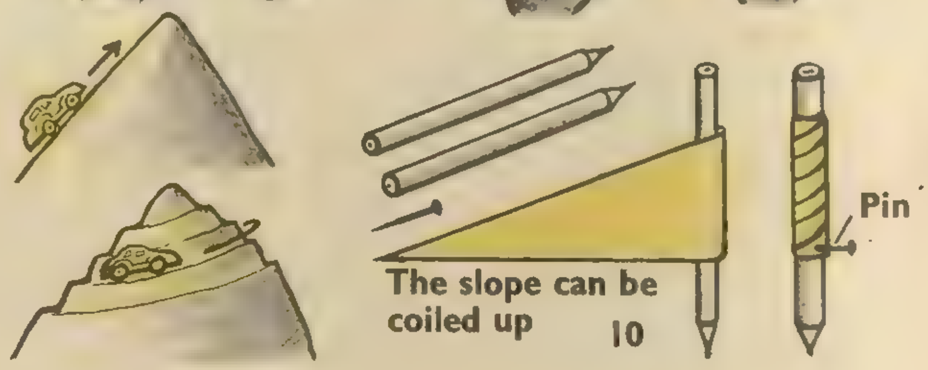
Screws are also 'slopes'. They help you to pull things together with great force. Wedges and the shape of axe heads and chisels are also slopes. These help to push things apart with very great force.

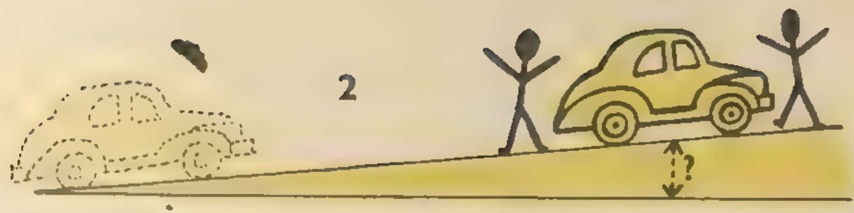
Make drawings of these other two kinds of slopes and put in small arrows to show which way the forces are acting.

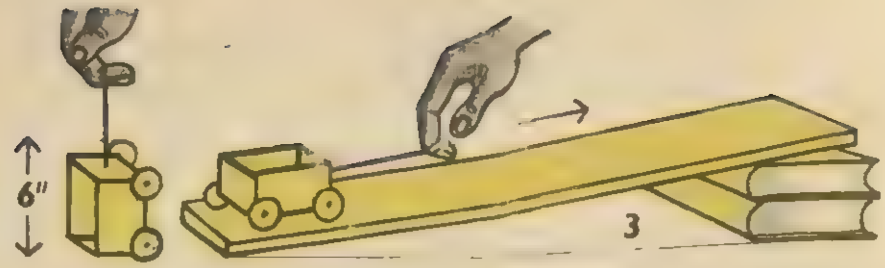
Write a list of as many kinds of screws, wedges and slopes used as machines, as you can think of.

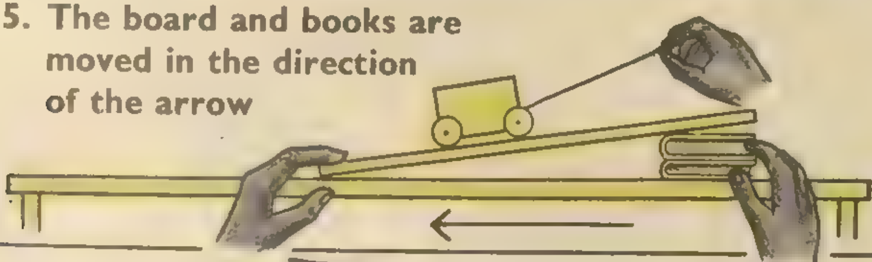




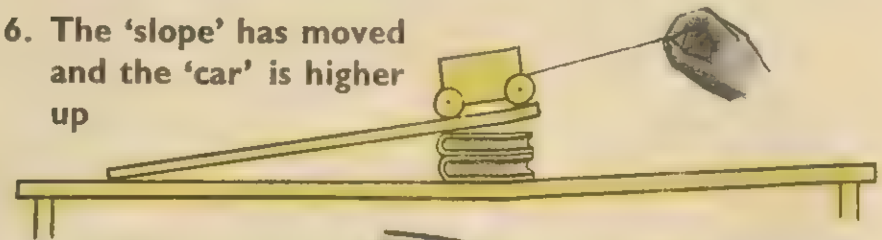




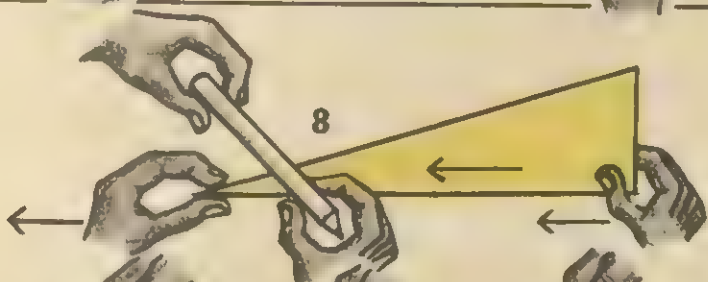


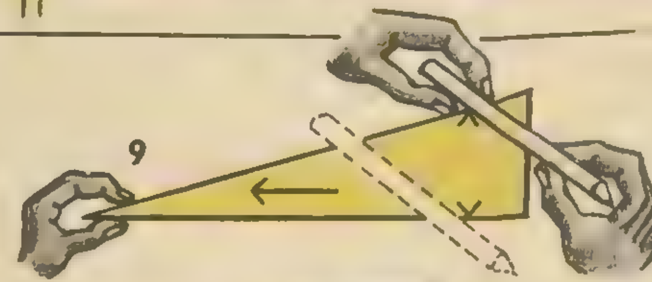


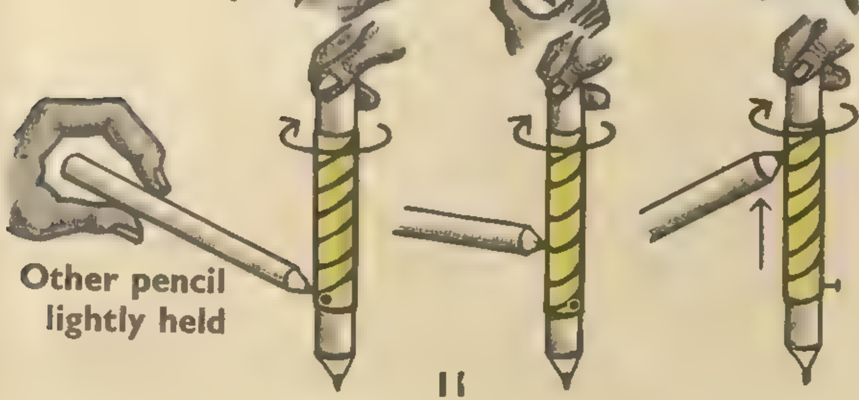
5. The board and books are moved in the direction of the arrow

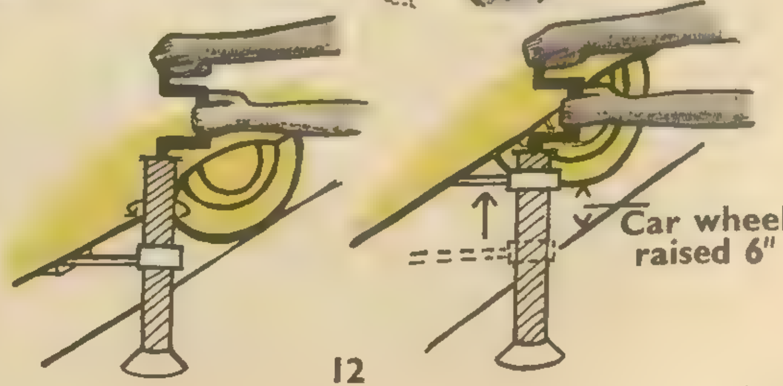


6. The 'slope' has moved and the 'car' is higher up









GEARS, SPEED AND POWER

Materials Required: tin lid, hammer, pair of compasses, $\frac{1}{2}''$ nails, $3''$ or $4''$ nails, blocks of wood, cotton reels, hairpin or wire, elastic bands, bottle tops.

This is to be done in groups.

1 and 2. The hole must be in the EXACT middle of the tin lid.

3. Small tacks or nails are used to fix the cotton reels to the tin, and a large nail is used to make sure that the reel is in the EXACT centre.

4 and 5. The large nail is now put through the reel the other way, and the 'pulley' fixed to a board.

6. Strong black thread is fixed, as shown, to the large and small pulleys.

7 is an experiment to show the easiest way of raising a weight with two pulleys fixed together. After you have done this experiment, draw the diagrams in your book, putting the easiest way of raising a weight on the left, and the hardest way on the right side of your page.

8 shows the same rule you discovered in experiments with the lever. Here the wheel acts as a special kind of lever with the turning point at the centre. To move a heavy weight a short way, the free end moves a long way using little force. On what does the comparison between the distances moved depend? Draw the diagram in your book, and write your answer by it.

9. Do you remember balancing coins on your ruler? Do the same thing with these pulleys. X and Y are the weights (use coins in match boxes), the centre of the pulley is the Turning Point and the edge the Free End. Set the problem down in the same way as on page 26.
Your teacher may set you other sums comparing the radii of the two pulleys and weights that will balance, or distances moved by the free end round the pulley.

10 shows you how to make a model well on your desk.

11 and 12. This introduces another use of a machine – to increase speed. When A moves round once, how far does B move? Measure the radii of the two pulleys. Divide one into the other. What rule does this give you about obtaining an increase of speed.? Write it down in your book.

13. Make this up in your group. Draw a sketch and answer these questions:

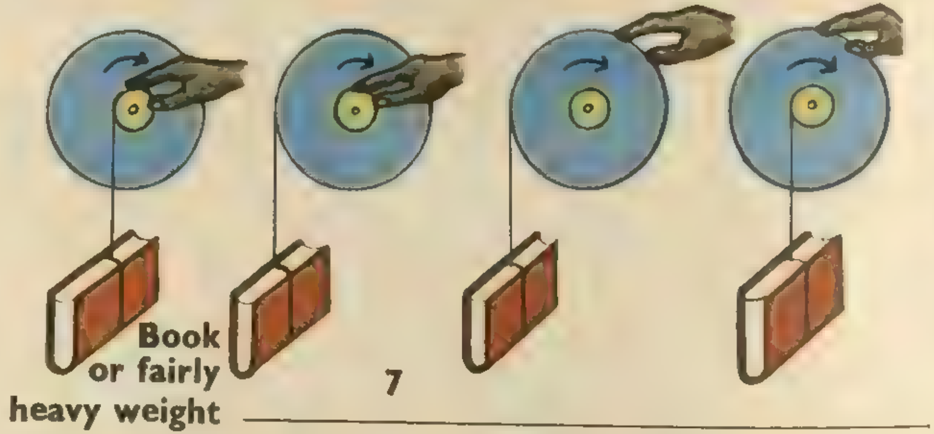
Is it easier to turn C or E? Why?

By measuring the radii of the pulleys that are joined by elastic bands, and dividing one into the other (C.D. and D.E.), work out in your book how many times E will go round if C is turned once.
Now see if it is true by doing it.

This arrangement can do two things. You can either move one wheel very fast by using a lot of force on the one at the other end of the machine, OR it can apply a great force (e.g. haul up a heavy weight) at one end, while the wheel at the other end is moved round a large number of times.

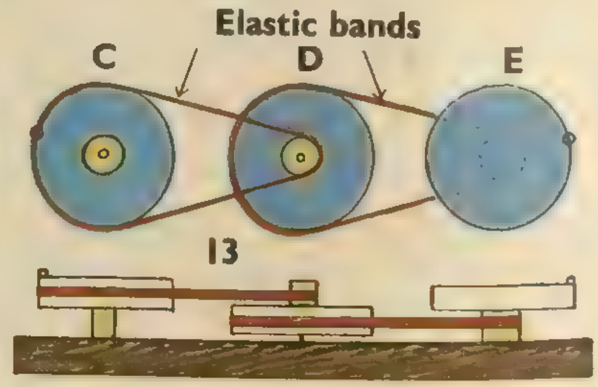
14 and 15 show another way in which wheels can be linked together. Be careful to drive the nail through the EXACT centre of the bottle tops. Each wheel goes in the opposite direction to the next one.

16. Here is another way of changing direction at right angles. Try it. Special toothed gear wheels do this where the shaft from the engine meets the back axle of a motor-car (picture 17).

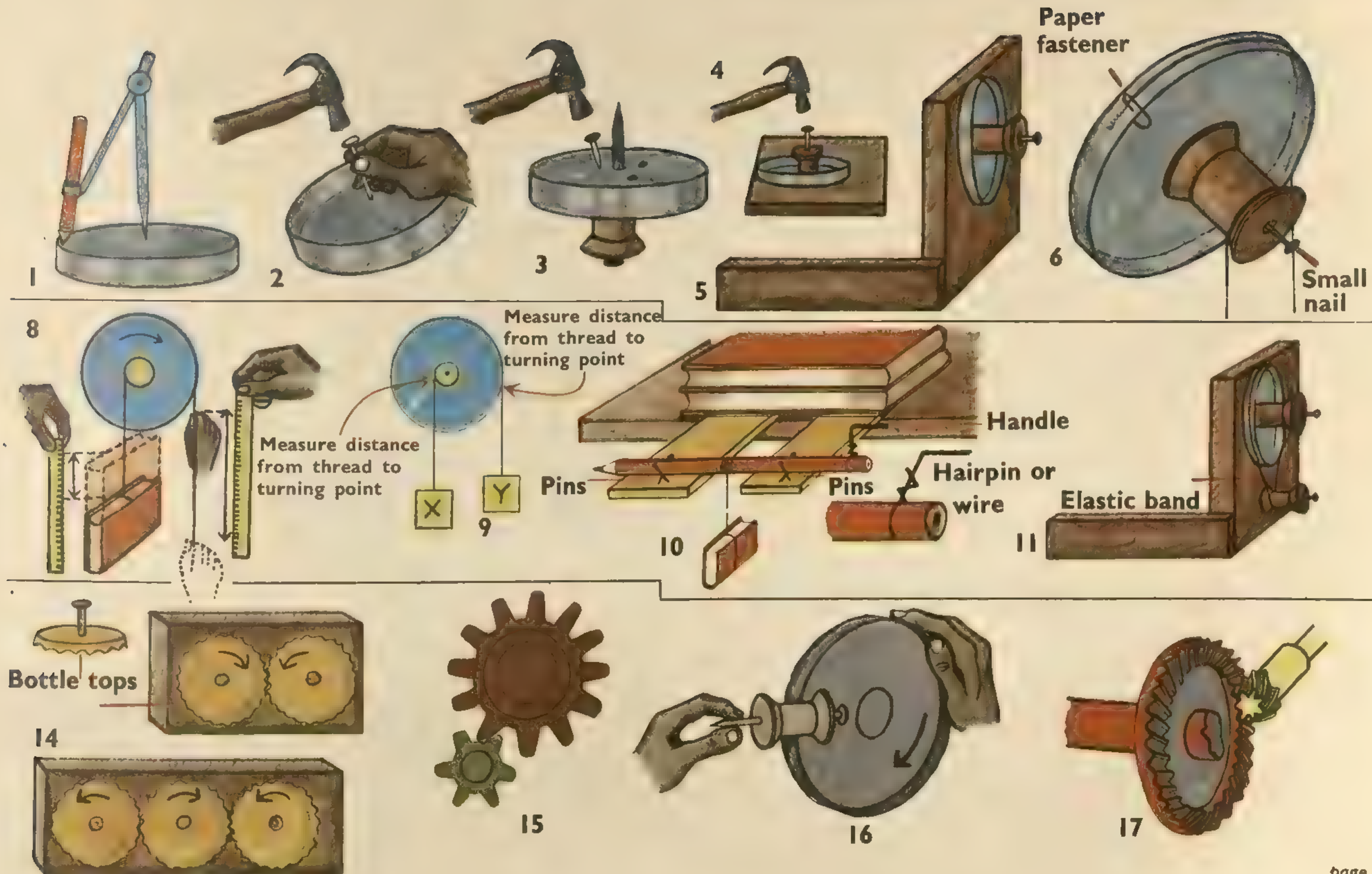


7

12



13


Paper fastener
1
2
3
4
5
6
Small nail
8
Measure distance from thread to turning point
Measure distance from thread to turning point
X
Y
9
Handle
Pins
Pins
Hairpin or wire
10
Elastic band
11
Bottle tops
14
15
16
17

FRICTION AND BRAKES

The engine of a motor-car drives the wheel at the back by a special arrangement shown in picture 17 on the previous page. Read this next explanation slowly and carefully.

The engine of a car will only turn comfortably at a fairly high speed. If you wish to travel slowly, the road wheels will have to turn more slowly than the engine. Gear boxes are an arrangement of gear wheels for making the road wheels turn at say a quarter, or a third, or half of the engine speed.

The change is made by moving the 'gear lever' near the driver's seat. You need to start to move slowly, and also if you are going up a very steep hill the 'low' gears give more power (see previous page), because the engine at one end of the 'machine' turns many times, while the place where the force is applied (that is the road wheels) turns less often.

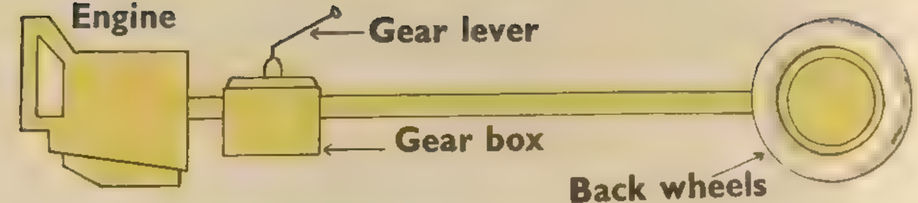
The gear box is much more complicated than the diagram shown here, but the drawings show you simply what happens inside at each change of speed.

1 and 2. Movement is often made very difficult by one thing rubbing against another. We call this FRICTION. This experiment can be done in front of the class. Write down what you discover from this. Rollers were probably used before wheels to overcome friction.

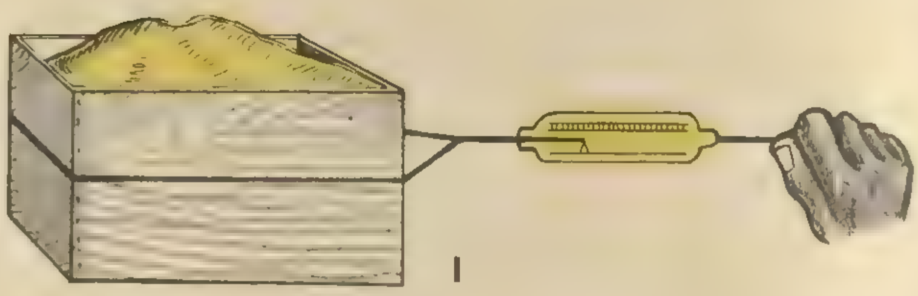
Friction or rubbing occurs even when wheels turn on an axle or rod. This is made better by oiling, and also by means of ball bearings. Where are these to be found on a bicycle? Spinning round on a lid full of round beads is very much easier than just spinning round with your feet on the floor. Some of you may like to try this – others may not!

5, 6 and 7. Friction is also used for stopping things which are moving quickly. 5 shows one kind of bicycle brake, and 6 shows what is called an expanding hub brake. To understand how these hub brakes work, try experiment 7 with a jar. One of you will press your thumbs outwards on the inside of the jar, while the other will try to turn the jar. In the brake it is the 'shoes' that stop the wheels turning, when they press against the side.

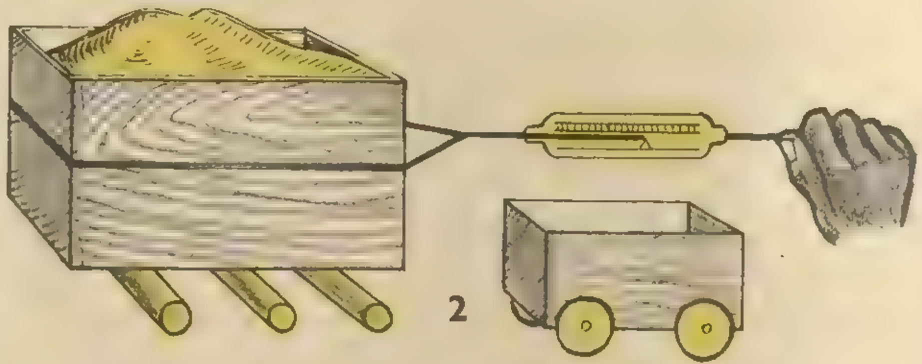
Examine a bicycle. Find the ball bearings, brakes and the points where you oil it. Show these in a labelled drawing.



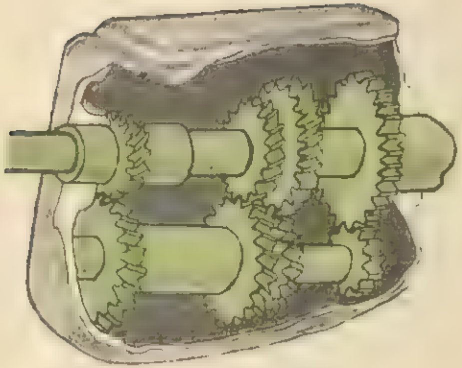
The gear wheels in the gear box change the speed and power of the back wheels



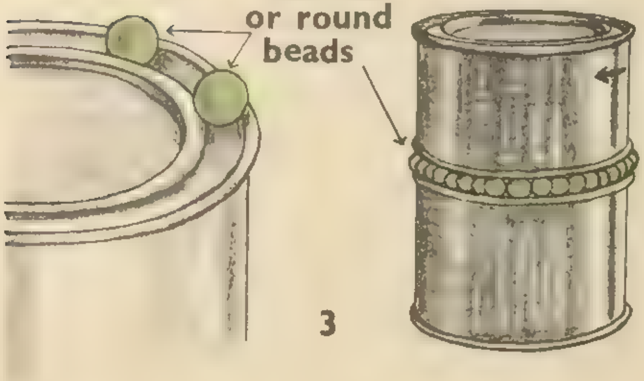
1



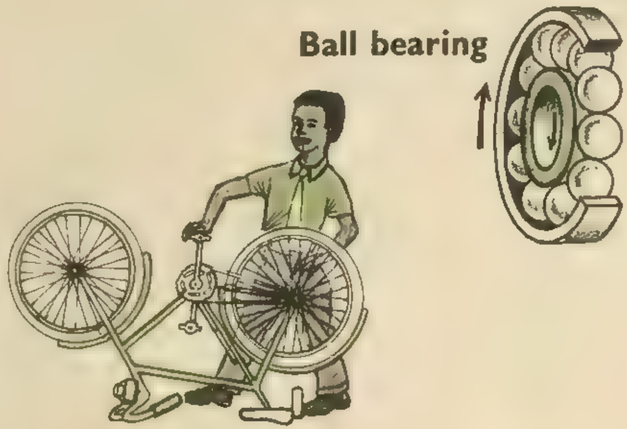
2

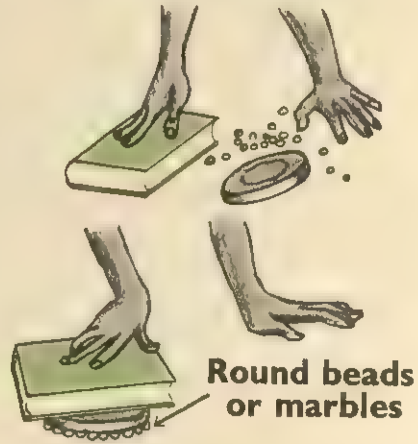


Bottom gear 0-15 m.p.h. Second gear 15-35 m.p.h. Top gear 35-70 m.p.h. Reverse - extra wheel to change direction

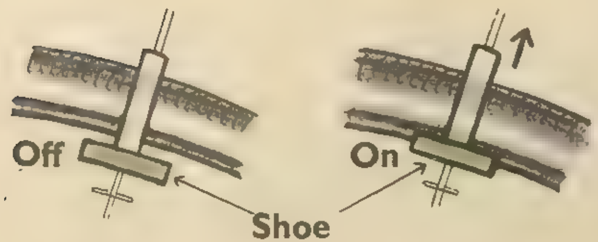


3

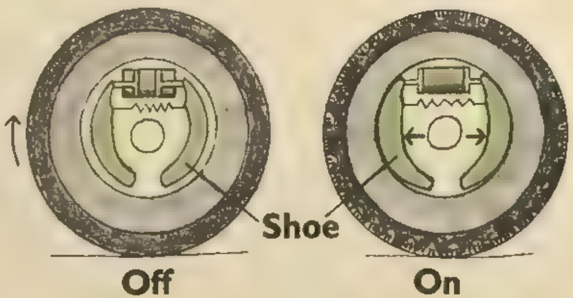




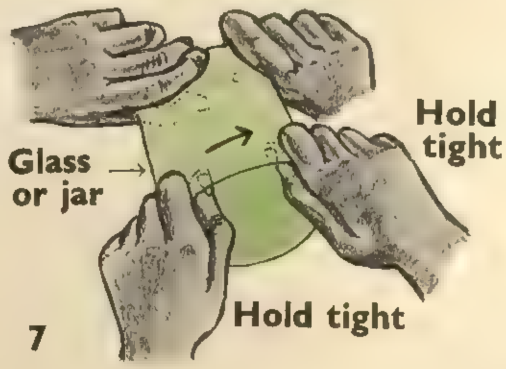
4



5 Bicycle brakes



6 Car brakes



7

Most of this page explains itself. These are a few examples of wheels that do special jobs. Big printing machines and paper mills are more complicated than are shown here, but these pictures show you how they work. Look at Pictures 1, 2, 3 and 4. Describe the special job done by the wheels in each picture.

Each of you can do the small experiment in the top right-hand corner of page 35. How does the wrinkling alter the way in which the card will bend? This experiment should explain to you the reason why we wrinkle a strip of metal. What two metals do we do this to for use in building?

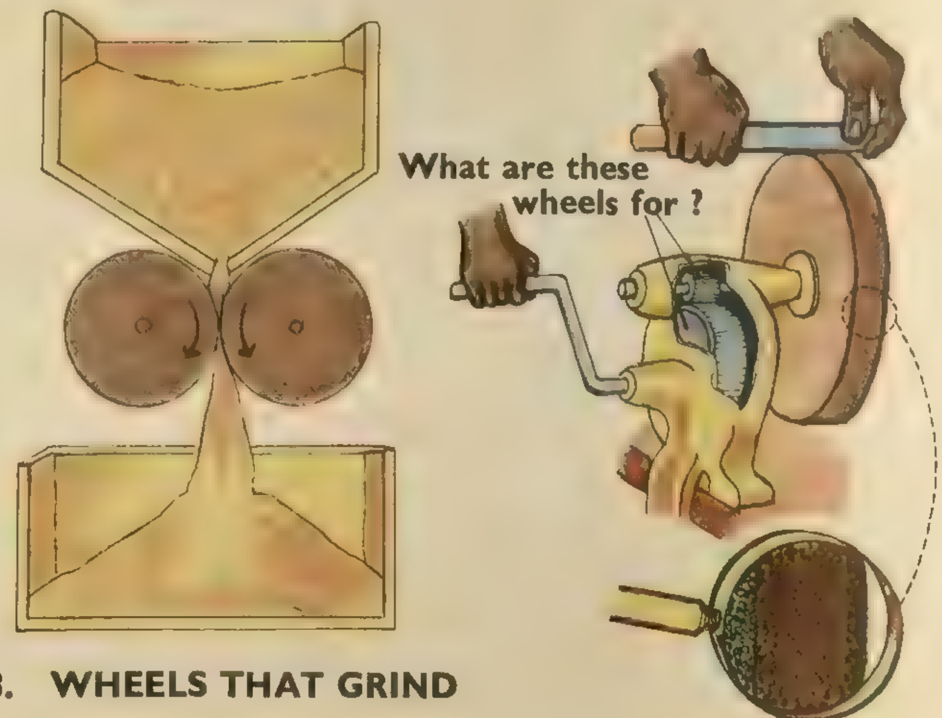
Look at the pictures on page 35 and write a short account of how paper is made. Think how many times wheels have been used in the manufacture, printing and transport of paper in this book.

Many of these pictures will remind you of the experiments you have already done. For instance:

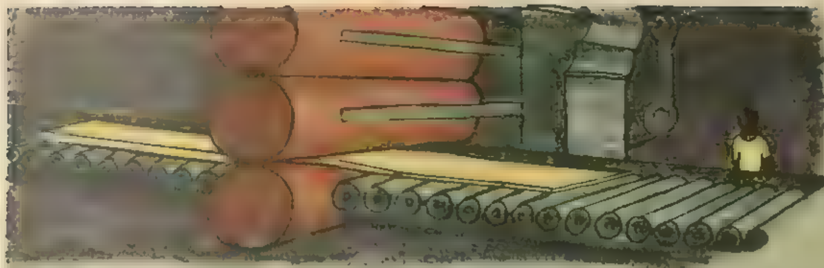
- Look at the picture of the grinding machine on page 34 and answer the question about the wheels shown in blue.
- Look at the picture of the mechanical shovel on page 35. Make a list of all the kinds of 'machines' that form part of it.

Draw a bicycle, not forgetting the brake levers and the bell, and label every 'machine' you find in it.

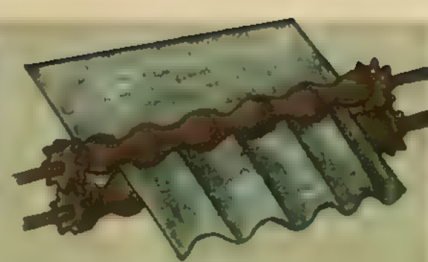
1. WHEELS THAT PRINT



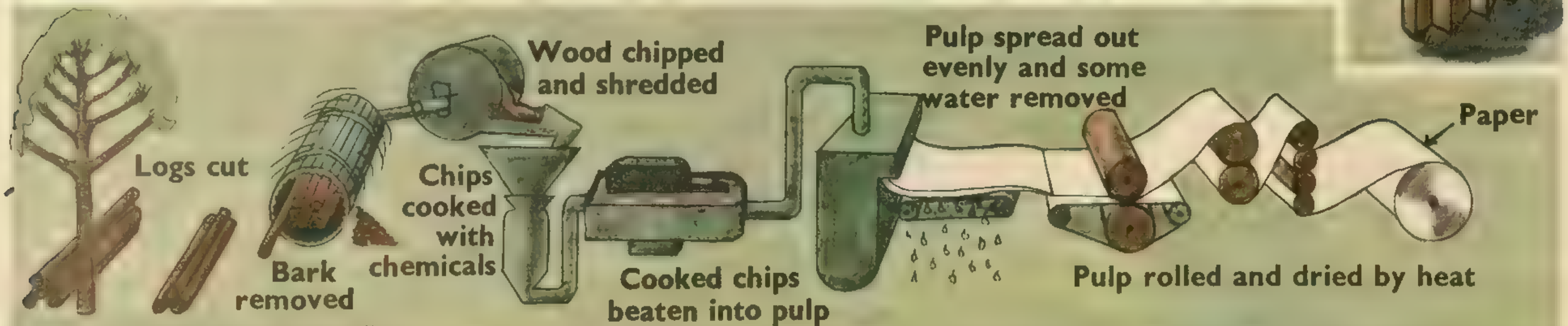
3. WHEELS THAT GRIND



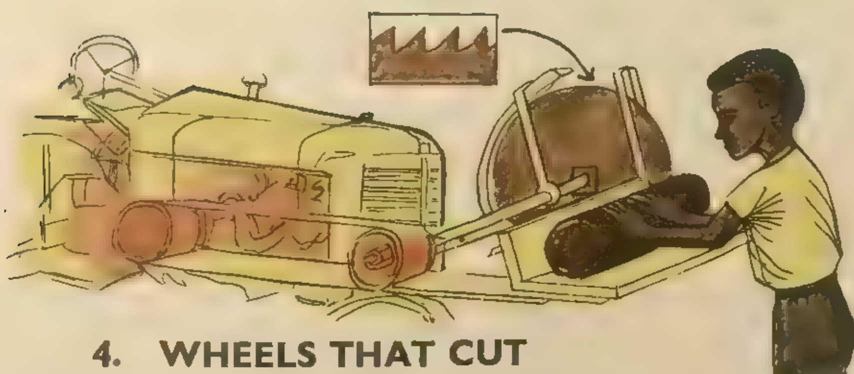
Steel plate being rolled out



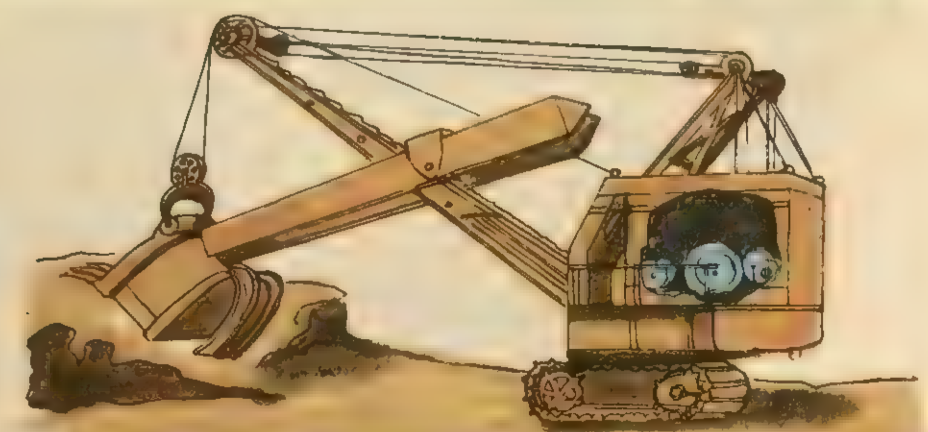
2. WHEELS THAT SQUEEZE



HOW PAPER IS MADE



4. WHEELS THAT CUT



MECHANICAL SHOVEL

MACHINES CALLED PULLEYS

Each group should make 2 pulley blocks. Two sizes of cotton reels are needed.

1. First use the larger size of cotton reel. Fix it to the wood with a 3″ nail, then file a groove with a triangular file.

2. Test the difference between these ways of lifting a weight.

Make drawings of other examples, that you have seen, of lifting things with pulleys and a rope.

3. Make these two pulley blocks, and hang them up from a table or from a chair placed on top of a table. Make sure the reels run easily.

Now measure how far you must pull the cord with your hand to raise the weight 3″, then 1″ and then 6″. Write your answers in table form:

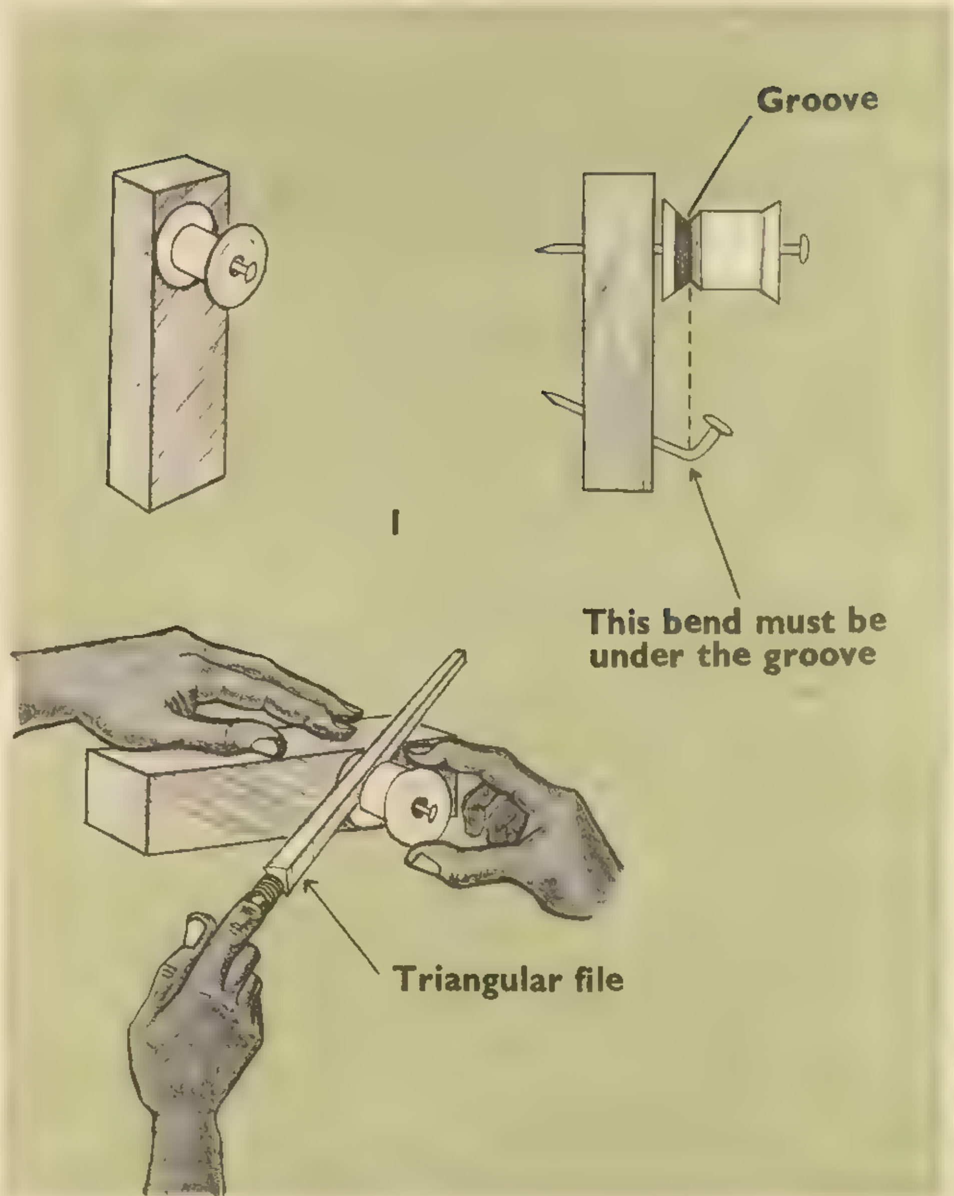
To move weight using 4 pulley wheels 3″, my hand must move ?″, etc.

Now try hanging weights on the rope X instead of pulling with your hand. Do you need a bigger or smaller weight to balance the weight at Y?

Write down what you have found out about this 'machine' called a pulley. How does it make work easier? Does the size of the pulley wheel make any difference to the special advantage you get?

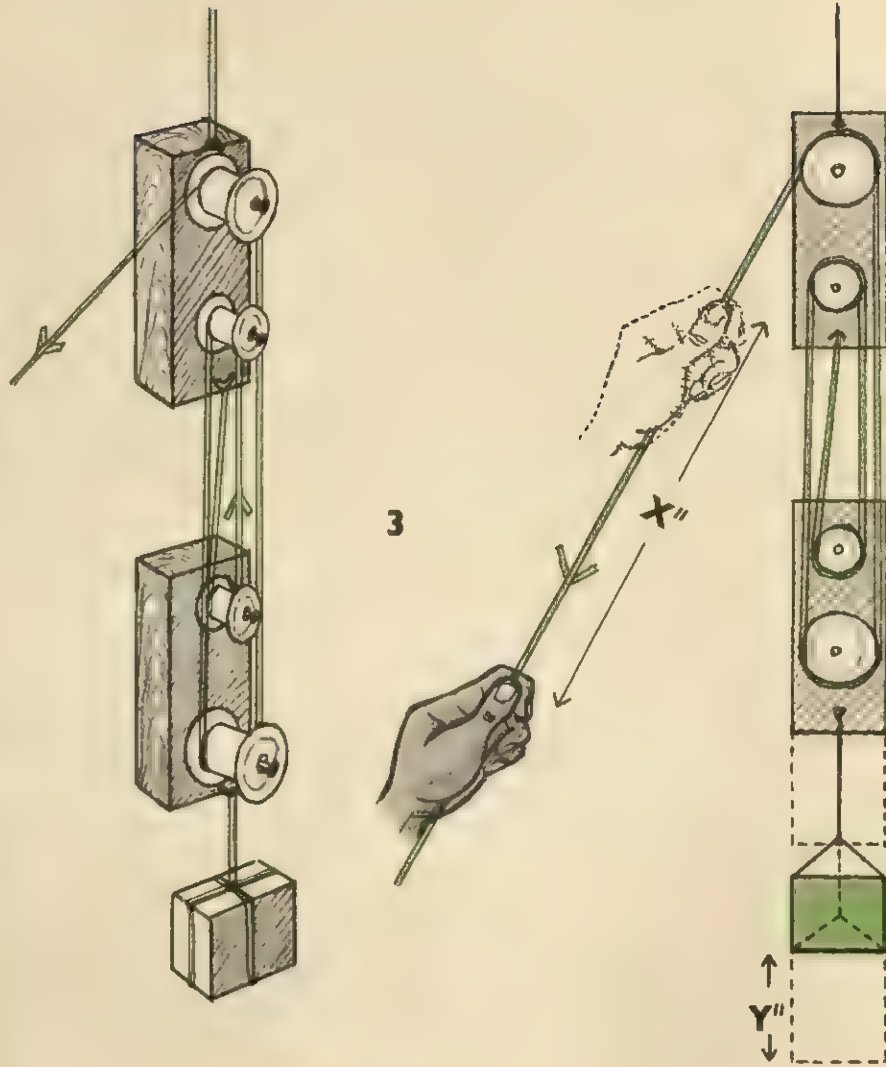
Draw pulleys which make lifting twice as easy, and three times as easy. If you have time try them out.

Notice that the same principles about weights and moving them apply as with the lever. Write down these principles again, this time for the pulley.



2

3



ABOUT TREES

1. If there are trees near your school, your teacher will take you out to make sketches like these. They show which are the big trees and which are the smaller kinds. They also show the shape of the trunk and the leafy part. You can often recognise a tree by these alone.

2. While you are out, you can measure the height of a tree. The 50′ string goes from the smaller stick A to the tree. The longer stick B is moved towards the tree until the nail on A, the nail on B and the top of the tree are all in the same line. The sticks MUST be kept upright.

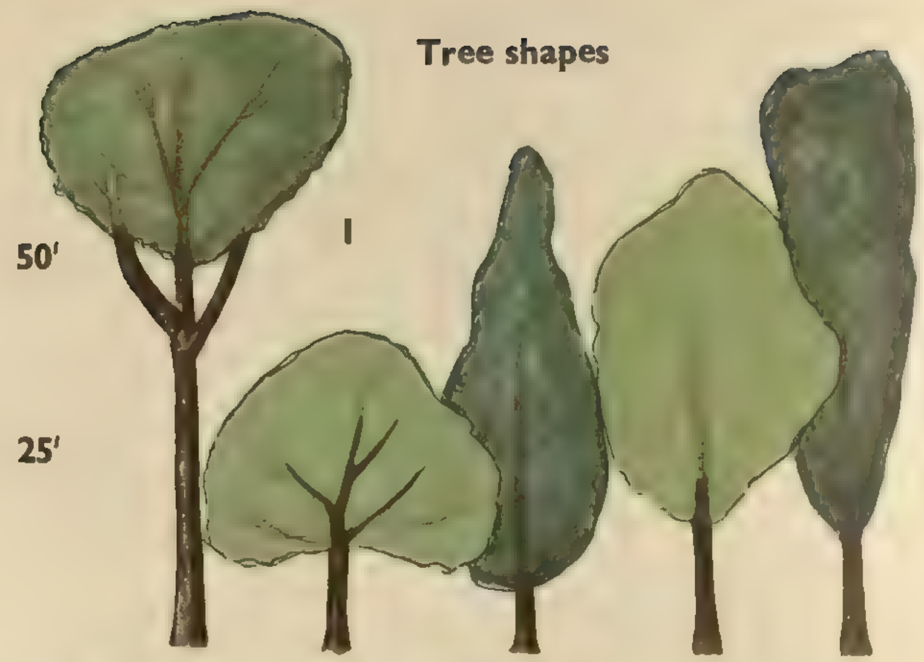
Next measure the distance between A and B. Divide 50′ by this distance. Multiply the answer by 2′. Add 5′ to this length. Then this is the height of the tree. Each group could try it with the same or a different tree if you have enough sticks, nails and string.

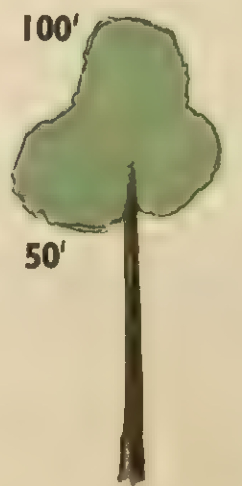
3. Bring to school a piece of maize stalk and the twig of a tree. The centre of the maize is filled with small pipes. Write down what you think these are for. The maize lives only one year. The tree also has these pipes inside it but adds new ones all the time it is growing. In the dry season they are very small and appear dark. During the rest of the year the new pipes that are grown are larger and do not look so dark. In this way year after year the dry season shows as a dark ring each time. Thus the number of rings tell you how old the tree is.

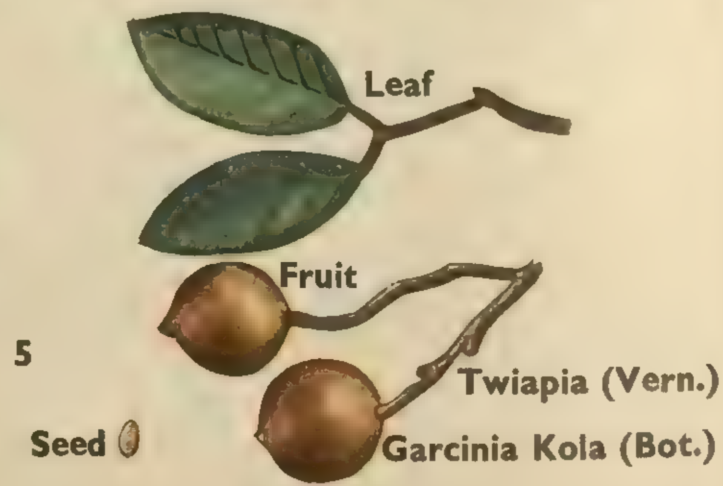
4. Find a tree stump near the school and mark it like this one, when you have counted the rings to find its age.

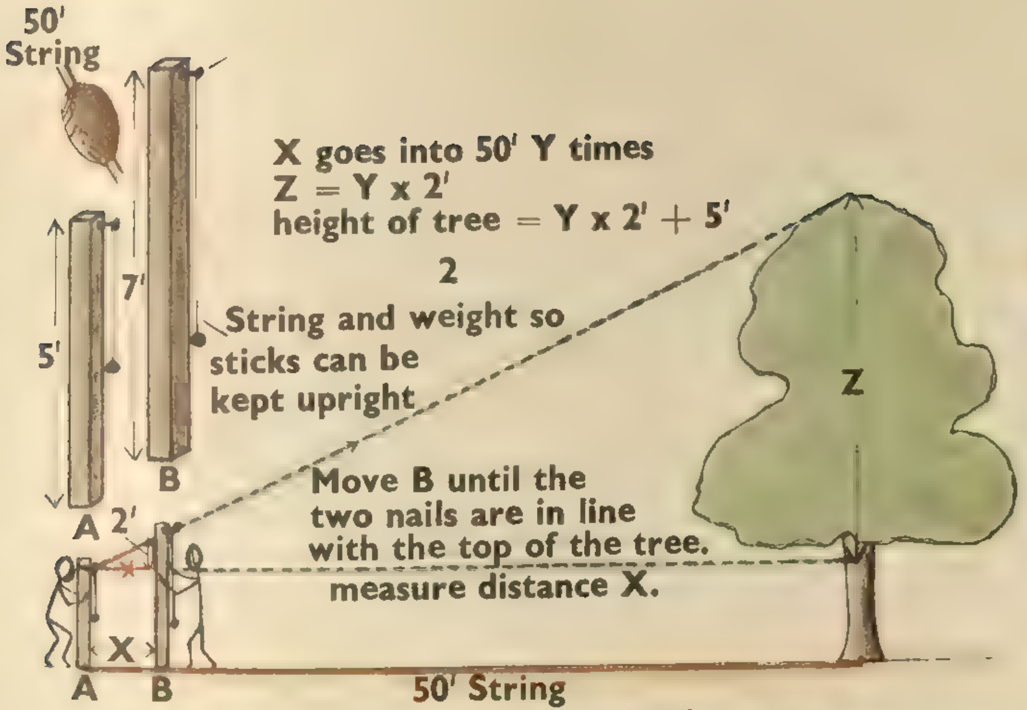
5, 6 and 7. Each group should bring to the Nature Table the leaves, fruit, and seeds of a different tree. The leaves, twigs, and seed may be stuck to a card. There should also be examples of the bark of the tree, a line drawing of the kind of veins on the leaves, and a sketch of the shape of the tree, with scale attached, to show the height.

All the class should then learn to recognise the collections made by every group. Make drawings of all the tree parts on your Nature Table and label them.





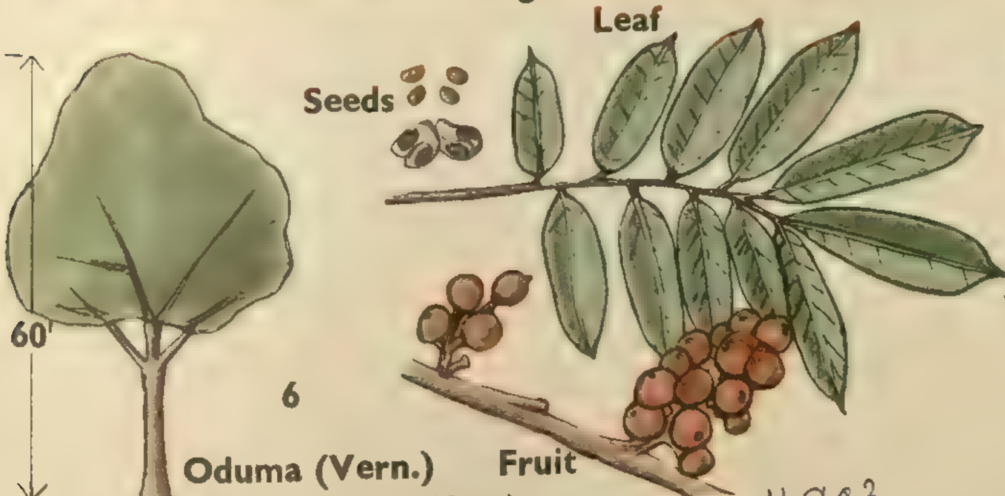




2

3

4



6

Oduma (Vern.)
Turraeanthus (Bot.)

11903

7

Smooth bark   Rough bar

8

BENDING LIGHT TO MAKE THINGS APPEAR BIGGER

A shows two ways in which you can see how light bends when it travels from air to water. Some groups can do 1 and 2, and some 3.

B1. See how bottles of different sizes bend the light from a torch. Draw your results in each case. You will find the point where the light is brought together before it spreads out again.
This point is called the FOCUS.

2. A magnifying glass does the same. (Magnify means make something appear bigger than it really is.) Try this and mark the focus on the paper.

C. Here is a way to make a small magnifying glass. The wire must be thin. Everyone in the class can make one. Try it on small things.

D1 shows how you can tell how much your glasses magnify. In 1 it is 4 times. Do the same yourself. Draw a diagram and write down by how many times your wire magnifier makes things bigger, then do the same with the ordinary one.

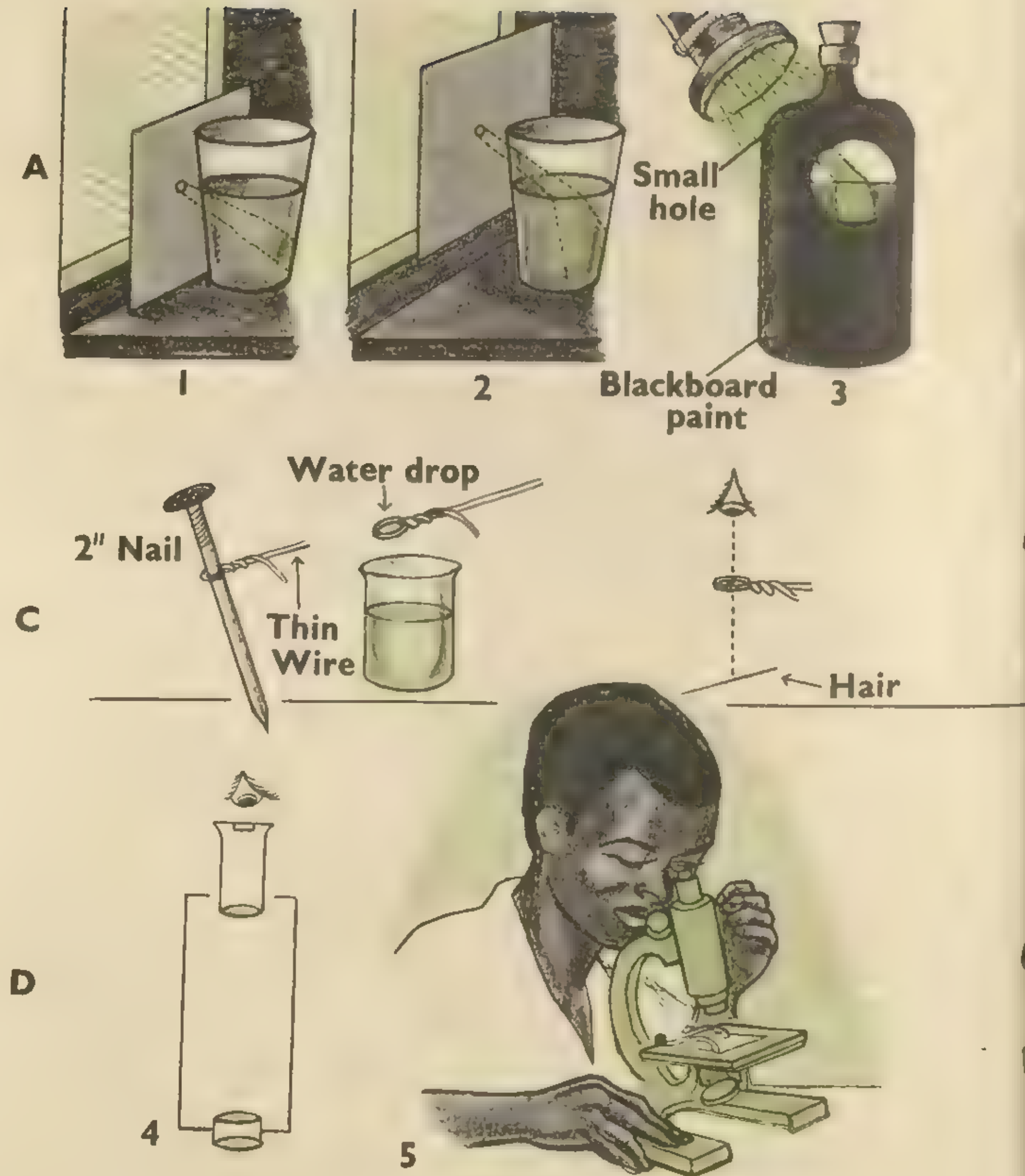
In 2 and 3 the glasses are close to the book. Write down what you have found out.

4 and 5. Using more than one glass or lens, the microscope can give a very big magnification, making things look, for example, three hundred times bigger. This means you can see things that no man's ordinary eye has ever seen. This is one of the great adventures of Science.

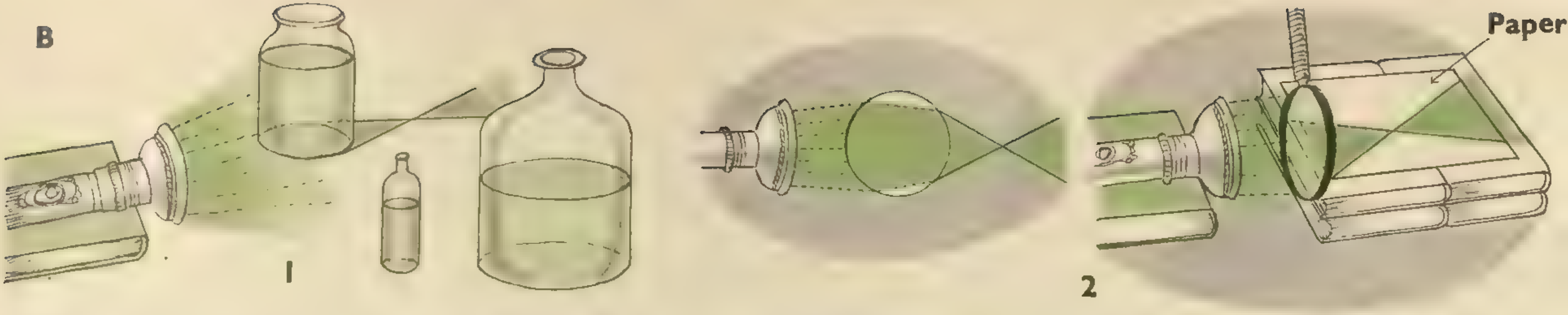
6. The lens is held away from the page, and the print is upside down. This is what happens in your eyes when you look at anything.

Each group should try 7. Move the two lenses about until you see the distant object sharply. This is called focusing. The lens in your eye is able to do this by itself.

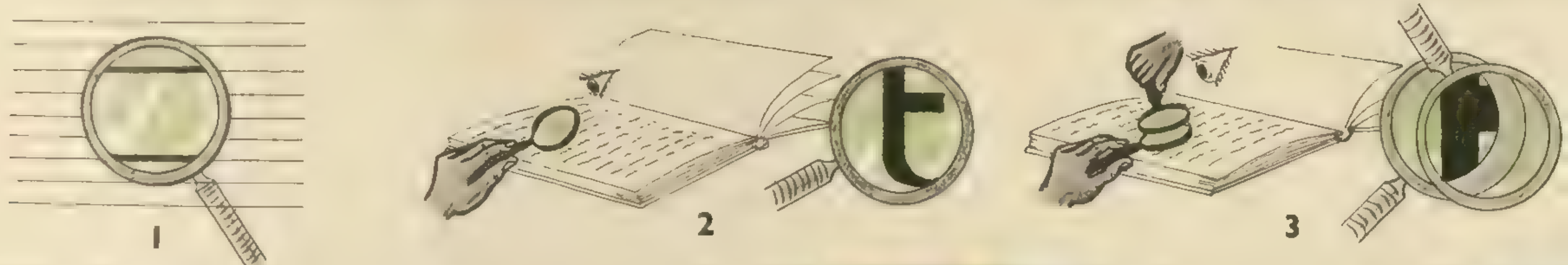
8 shows a telescope. The tube X moves inside the tube Y, so you can focus. In X there is a different shape of lens, which causes the picture to turn the right way up again. What is this difference in shape?

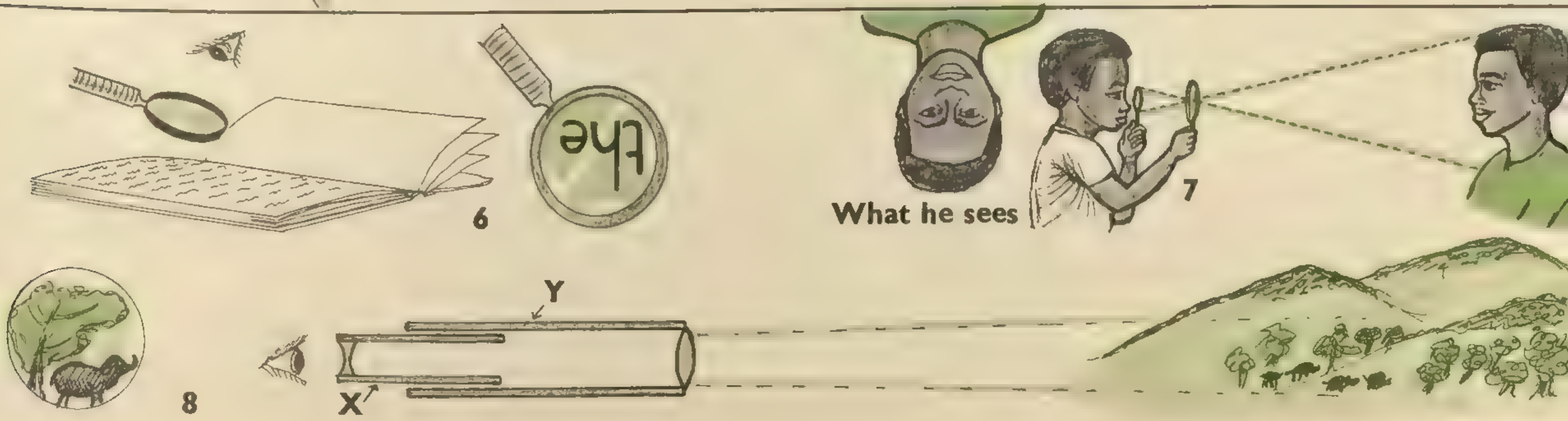


B



D





SEEING THINGS IMMENSELY FAR AWAY

Here is a giant telescope used by Astronomers (men who study the stars).

Our sun is a star, one amongst millions. It is over 100,000 times bigger than the earth, like a football compared with a very small bead. It does not look so big because it is 93 million miles away. So if you hang a football to one goal post, and hold the bead at the other end of a football pitch (120 yards), you will then have a good idea of the sizes and distances of the sun and earth. Go out and do this.

If you hold a pin about 2" from the bead, the pinhead will be just about right to represent the moon going round the earth.

Telescopes show us the mountains on the moon, and also the great holes in the flaming surface of the sun. We call these sunspots, and they are not always in the same place. Sometimes they affect our radio sets.

Like the other planets the earth moves round the sun spinning at the same time. The earth is one of the nearest of the planets to the sun. The diagram shows how the planets travel round the sun.

Distances – when studying the stars we must get used to terrific distances, distances so great that the human mind can hardly understand them. We will keep our enquiries to the sun and the planets, which all together are called our solar system.

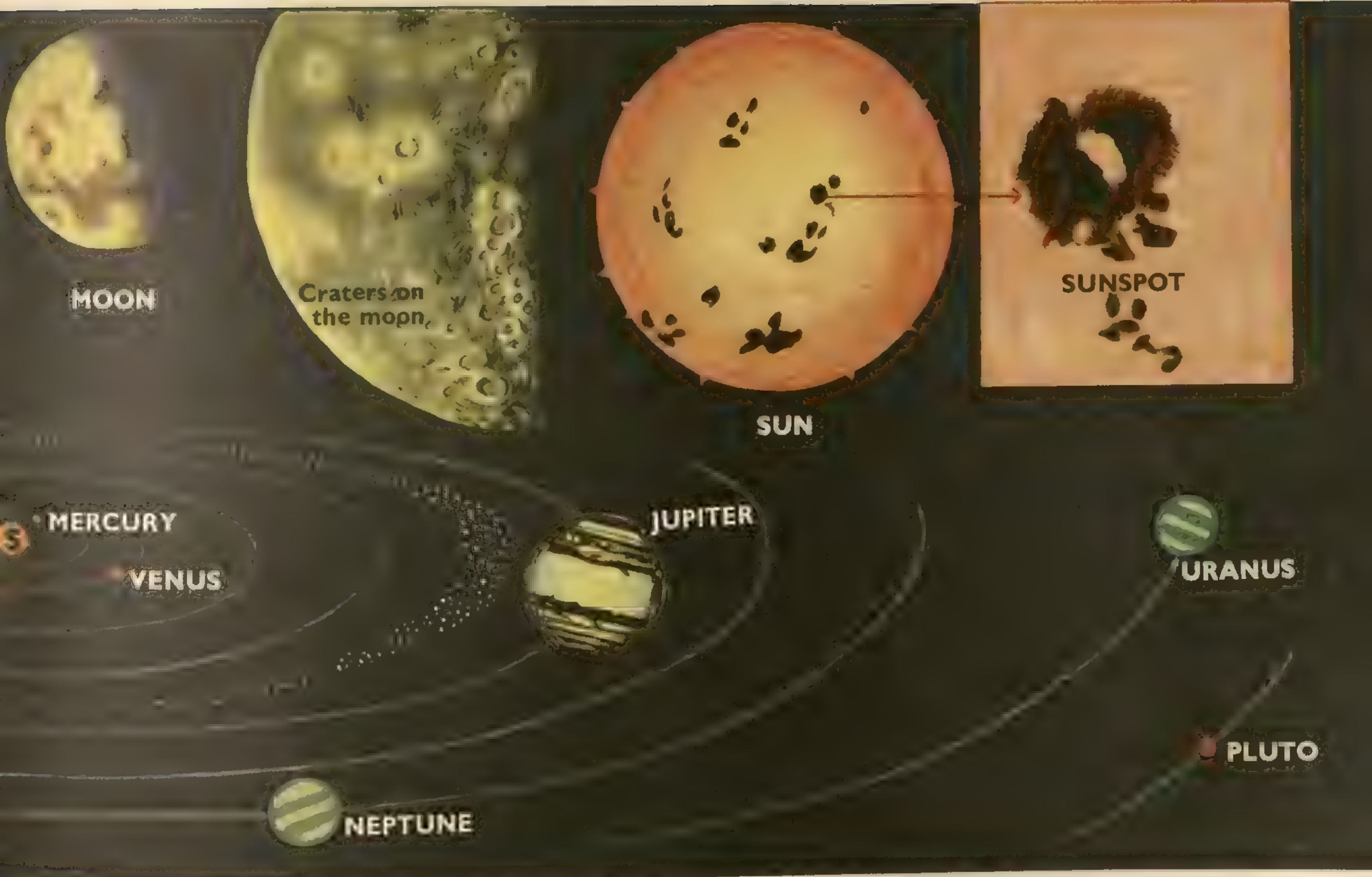
Below is a table, and later a few sums to work out. Try and keep in mind your visit to the football field – the football, the bead and the pinhead – and you will begin to have some idea of what these figures mean.

Planet	*Diameter in miles*	*Average Distance from Sun in million miles*	*Number of Moons*	*Time taken to spin round itself*	*Time taken to travel round the Sun*
Mercury	3,000	36	0	88 days	88 days
Venus	7,700	67	0	uncertain	225 days
Earth	7,913	93	1	24 hours	365¼ days
Mars	4,216	142	2	24½ hours	687 days
Jupiter	86,700	483	12	10 hours	12 years
Saturn	71,500	886	9	10¼ hours	29½ years
Uranus	32,000	1,780	5	11 hours	84 years
Neptune	28,000	2,800	2	16 hours	165 years
Pluto	8,000	3,700	Not known	uncertain	248 years

Work out the following sums:

1. How far does the earth travel round the sun in a year?
2. How fast does it travel? (A difficult sum.)
3. How many times farther away from the sun is Saturn than the Earth?
4. If the Earth can be represented by a bead a hundred yards away from a football (the sun), how far away from the football would you take another, larger, bead to represent Saturn?

Asteroids may be parts of another planet that broke up into small pieces.


MOON
Craters on
the moon
SUN
SUNSPOT
MERCURY
VENUS
JUPITER
URANUS
PLUTO
NEPTUNE

EYES AND CAMERAS

1. Windows will have to be partly covered with a blanket for a short time to do this. Have one group at each window.

2. Even for this the room may have to be darkened a little. The needle hole acts as a lens. Photographs can be taken by these pin-hole cameras.

Draw what you see when you look at the lighted candle.

3 shows an ordinary box camera with the back open. Tracing paper is fixed across the open back with an elastic band. When you look through it at a scene you will see it upside down. Your teacher will have to show you this, one at a time, with a camera.

4 shows how your eye is like a camera. The lens is a very wonderful one that can make itself thick or thin, in order to be just right for the thing you are looking at. The picture is thrown on to the back of the eye, on a part called the RETINA. This is very sensitive, and is connected by nerves to the brain, which is where you really 'see'.

In front of the lens is a sort of shutter called the IRIS, to shut out light when it is too strong.

The PUPIL of the eye is really just the hole through to the lens.

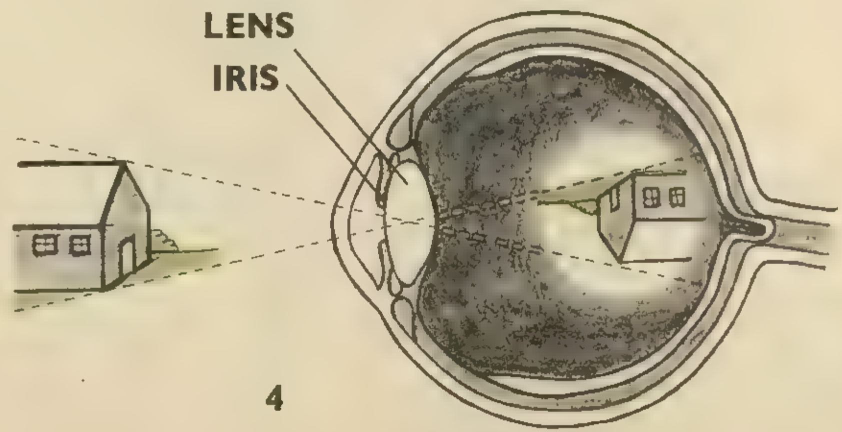
5 shows the muscles which move the eye about.

6. Do this in pairs. Your partner faces the window, and closes his eyes and covers them. After ten seconds tell him to take his hands away and to open his eyes. Watch his eyes carefully. At the moment the eyes open, you will see the iris closing till the pupil is small. In the dark will the iris open or close?

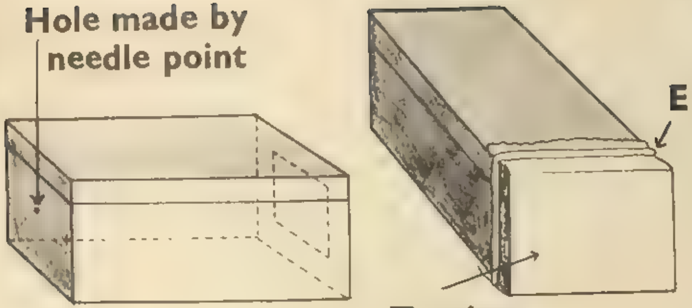
7. We have two eyes so that we can tell how far away things are. Hold one hand out with the finger pointing upwards. Close one eye. Now pick up a pencil from the desk and try to touch that finger with the pencil point straight away, all in one moment without a pause. Then close the other eye and do the same. Do it lastly with both eyes open. Write down what you have found out.

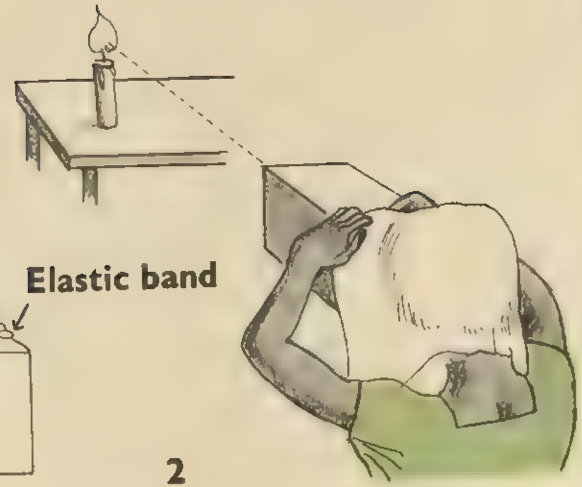
Write a short account called 'How Our Eyes Work'.

1

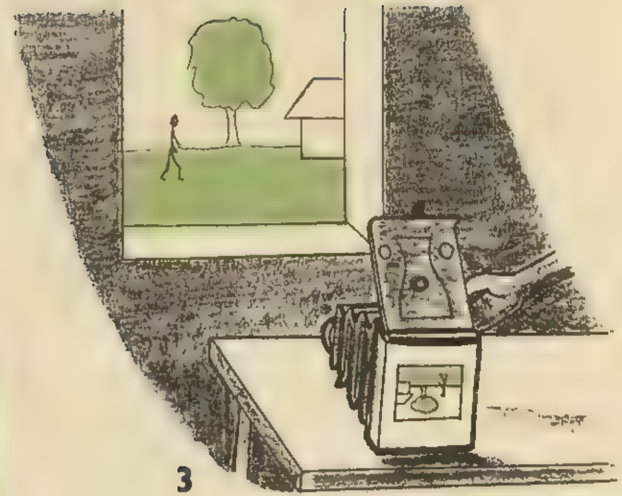


4

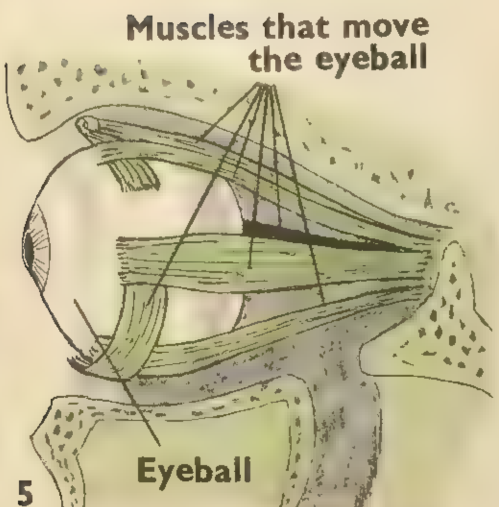

Hole made by needle point
Elastic band
Tracing paper



2

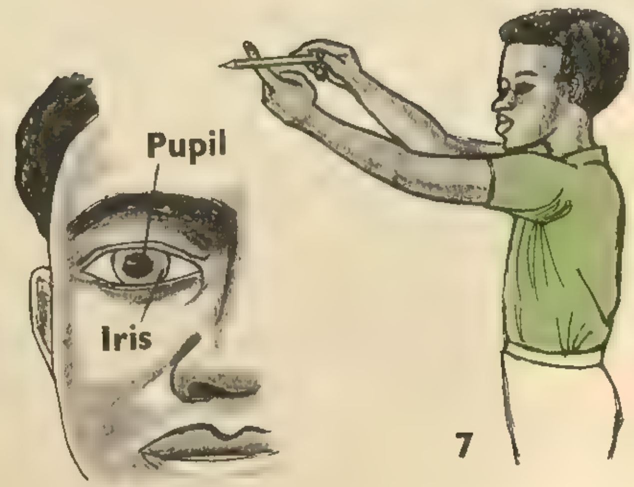


3


Muscles that move the eyeball
Eyeball

5

6


Pupil
Iris

7

SEEING THINGS TOO SMALL FOR ORDINARY EYES

1. Remove the outer layers of an onion until it is pale green in colour. With a knife peel off the thinnest possible skin, and put a piece on the glass slide. Drop some water on it, then hold it up to the light and look at it through a mangifying glass. Draw exactly what you see.

2 shows you the sort of thing you should see. The thin layer of onion skin is made up of 'living bricks', all put together to form a layer of skin like the stones or bricks in a wall. The 'living bricks' in onion skins are larger than most 'living bricks'.

3 shows a 'microscope', a special magnifying machine which can make a single CELL (living brick) look very large.

4. There are many different kinds of cells, but everything that is alive is built up from them, just as a wall is built of bricks.

Each cell has a skin or shell round it. Usually you can see through this as if it were glass. In plants the case or shell is usually hard. In animal cells it is usually soft, except in the cells that make up bones and teeth and fingernails.

5. You will not see a cell as big as this except through a microscope, but look at it closely. There are two other things that you always find in living cells. The first is a special liquid, thicker than water, with the scientific name of PROTOPLASM. This is the substance that is really alive, and it is a very wonderful substance.

In the protoplasm there is also a specially thick lump of protoplasm called the nucleus. It is the special lump of dense protoplasm that is able to make the cell grow, and also to divide into two.

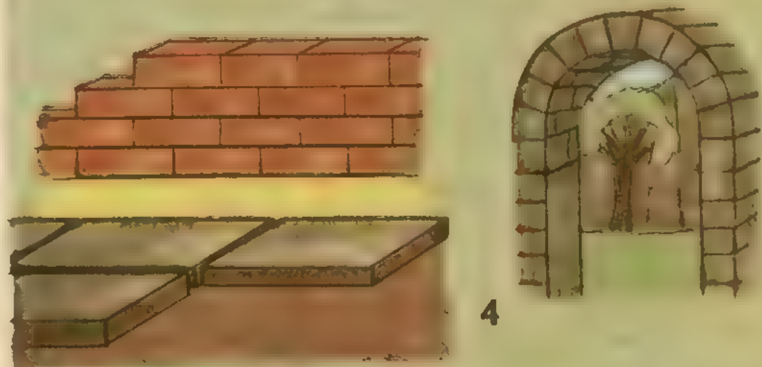
You will learn later about the wonderful things that are happening even now to the cells in your body, especially the parts that are growing.

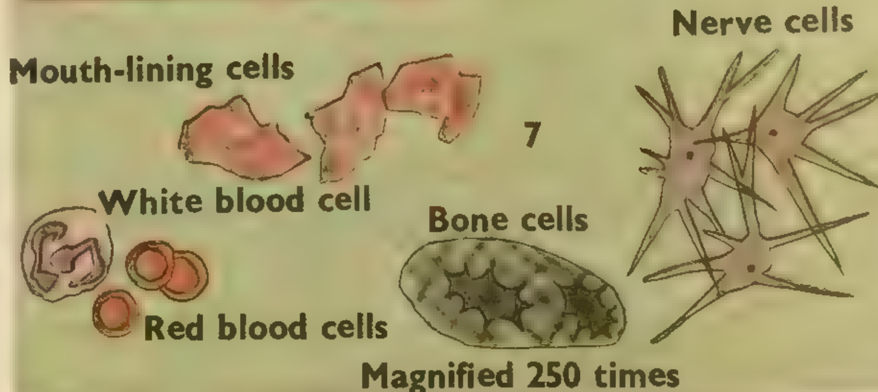
6. These are pictures of cells from our bodies. They can only be seen through a microscope.

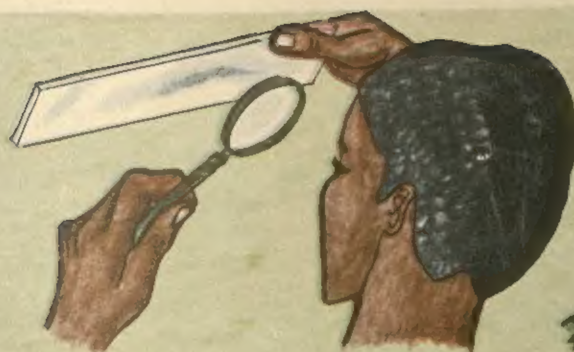
8. These are small cells that are not 'bricks' making up a big animal or plant, but they live separately in water that is unfiltered and unboiled.

9 shows some living things SMALLER than cells. They are called BACTERIA and some of them cause disease. (A million would only cover a full-stop on this page.)

Draw a square $\frac{1}{4}''$ by $\frac{1}{4}''$. Now draw one 20 times as big. This is what your magnifying glass will do. Draw one 100 times as big – this is what your microscope will do.



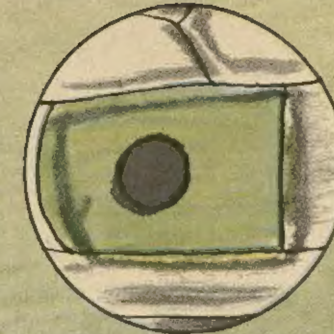




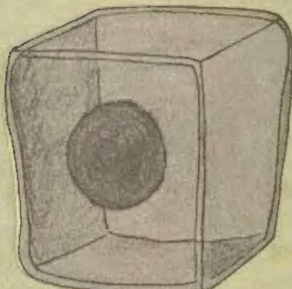
2

● Magnified 12 times

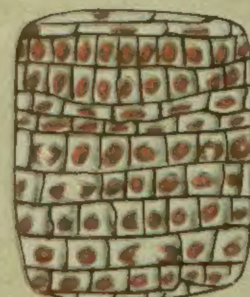
3



Magnified 150 times



5



Small cells from tip of root magnified 250 times

6

Cells of human skin magnified 250 times

Muscle cells magnified 500 times

8

One-celled animals in pond water magnified 200 times

Anthrax

Pneumonia

Magnified 2000 times

Boils

Diphtheria

Magnified 2000 times

9 BACTERIA CAUSING DISEASES

Notes to Teachers

Study carefully the list of apparatus and materials required (see opposite). It is very important that you collect materials early, preferably before term begins. DO NOT LEAVE IT UNTIL JUST BEFORE THE LESSON.

Have about three large shallow boxes, e.g. 3′ × 3′, in which to store your material. A nature table for display is a necessity. (See Book I.)

It is absolutely necessary that *you* do *every part* of *every experiment before* you get the children to perform it. This is the *only* way the Course will work.

The List of Contents gives instructions about the time and order of the topics. These instructions *must* be followed.

No special method has been adopted to show you what needs early preparation for a lesson. Look carefully through the page two weeks before you are due to deal with it in class.

In this book information has been added to what the children find out for themselves. It is the teacher's duty to make sure that such information is really understood and not merely learned by heart.

Do read the books listed and, if necessary, seek help with any topic you find difficult.

There are many additional experiments that may occur to you, and which may increase the children's understanding of how things work. If you have time, by all means add them to the work after you have first tried them out.

You will add verbal explanations, pictures, and illustrations of all kinds to the work of this book.

Nevertheless the basis of the method remains the practical discovery of 'how things work' by the children themselves. Your chief task is to be an efficient organiser of their discoveries.

Note Books

Throughout the Course the most difficult part is for pupils to produce evidence on paper that they have understood the lessons. You will have to help many of them to do this in English. Be very careful that you *do not provide them with answers to* the questions which they write down and learn by heart. Nothing will be more likely than this to label your science teaching as a failure.

Pupils must have a book in which they can keep a Nature Diary and where there is provision for sketching as well as for writing. The Diary will contain records of the agricultural activities of the pupils as well as observations of living things in and out of the classroom. One half of the book should be set aside for the diary (see Book I).

Books for Teachers and Pupils

RURAL SCIENCE FOR TROPICAL SCHOOLS, Bks. 1, 2, 3 and 4 T. M. Greensill, Evans
BIOLOGY AND HYGIENE FOR TROPICAL SCHOOLS, Bks. 1 and 2. M. S. Nielsen, Evans
WEST AFRICAN BOTANY F. R. Irvine, Oxford University Press
ELEMENTARY BOTANY FOR WEST AFRICA E. M. P. Walters, Allen and Unwin
ANIMAL LIFE IN THE TROPICS E. M. P. Walters, Allen and Unwin
A NEW TROPICAL HYGIENE Goodwin and Duggan, Allen and Unwin
ABOUT A MOTOR CAR Phyllis Ladyman, Puffin Picture Book
FRIENDS AND ENEMIES IN THE GARDEN, Booklets 1–6
FARMING SERIES, Booklets 1–10
THE GARDEN SERIES, Booklets 1–6
All by Gwen Cross, Longmans (*Tropical Library*)
SMALL MAMMALS OF WEST AFRICA A. H. Booth, Longmans
BIRDS OF THE WEST AFRICAN TOWN AND GARDEN J. H. Elgood, Longmans

Books for Teachers

* THE TEACHING OF SCIENCE IN TROPICAL PRIMARY SCHOOLS E. D. Joseph, Oxford University Press
RURAL SCIENCE FOR SECONDARY SCHOOLS J. D. Clarke and G. N. Herington, Longmans
TEXTBOOK OF HYGIENE FOR TEACHERS IN WEST AFRICA W. N. Taylor, Longmans
* U.N.E.S.C.O. SOURCE BOOK FOR SCIENCE TEACHING, Unesco
* TEACHING SCIENCE TO THE ORDINARY PUPIL Laybourn and Bailey, University of London Press

Note. This list is in addition to most of those given in Books 1, 2 and 3

* *Minimum reference books for this Course*

List of Apparatus and Materials

Requiring Special Order	*quantities*
Hand lenses, minimum magnification X 15	8
Microscope slides – plain	1 box
Spring Balance – 1,000 gms.	1

Local Purchase	
Desiccator Jar to keep Hand Lenses (Local Photographic store)	1
Mirrors – small rectangular (Lady's Handbag)	12
Candles	4 lb.
Hoes	20
Garden Spades	4
Garden Forks	4
Hammers – medium weight	4
Gimlets	2
Small saw – Tenon	1
Nails, 3″	½ lb.
Nails, 1″	¼ lb.
Nails, ½″ brads	¼ lb.
Pins	1 pkt.
Sewing Needles	1 pkt.
Strong Black Thread	1 reel
Large Enamel Bowls	4
File, triangular	4
File, flat (fine)	1
Mosquito Netting (metal)	1 sq. yd.
Rubber Bands	1 pkt.
Drawing Pins	1 pkt.
Tracing Paper	6 sheets
Shallow Baskets for carrying soil	20
Unslaked Lime	4 lb.

Improvised from Local Sources	*quantities*
Round Beads, large and small	
Cotton Reels (two sizes)	4 doz.
Tins, assorted sizes	
Tin lids and Bottle Tops	
Wooden Boxes (e.g. Soap boxes)	
Jars	
Bottles, round, of various diameters	
Medicine bottles (flat)	
Cards and cardboard	
Paper	
Hairpins	
Corks	
Wire, thin copper, e.g. from car generator windings	
Oil, lubricating	
Match boxes	
String and strong cord	
Worn car parts. Ball bearings, Brake shoes, Gears, etc.	

To be Borrowed

Coins
Toy Cars
Car Jack. Car if possible
Umbrella
Pressure Lamp
Football
Small rubber ball
Camera (Box type if possible)
Electric torches

LONGMANS

LONGMANS, GREEN AND CO LTD
48 Grosvenor Street, London, W 1
Associated companies, branches and representatives throughout the world

First published 1962
Second edition 1963

Printed in Great Britain
by THOMSON PRINTERS LIMITED